PHASE II ENVIRONMENTAL SITE ASSESSMENT EAST PORTION OF PARCEL 307-D-001 NORTH OF CENTER STREET MCKEESPORT, PENNSYLVANIA

Prepared for:

TURTLE CREEK VALLEY COUNCIL OF GOVERNMENTS
2700 MONROEVILLE BOULEVARD
MONROEVILLE, PENNSYLVANIA 15146

DECEMBER 2014



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Prepared by:
KU RESOURCES, INC.
22 SOUTH LINDEN STREET
DUQUESNE, PENNSYLVANIA 15110

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EXECUTIVE SUMMARY

This report presents the results of the Phase II Environmental Site Assessment (ESA) conducted on behalf of the Turtle Creek Valley Council of Governments (TCVOG) for the East Portion of Parcel 307-D-001, located north of Center Street in McKeesport (Allegheny County), Pennsylvania (i.e., the Property).

The Property encompasses approximately 1 acre of vacant, former industrial land. The Property is recorded in the Allegheny County Tax Assessment as the east portion of Parcel 0307-D-00001-0000-00. The Property and adjoining properties were historically utilized as portions of a larger industrial facility, the Industrial Center of McKeesport. More specifically, the National Tube Works/Company produced steel tube and pipe of varying sizes and characteristics on this larger property. The Property specifically consisted of the former Laddle Repair Building and a portion of the Blowing Room structure. In 1987, the National Tube Works shut down. Since circa 1987, the Property has been vacant.

The historical site characterization reports that included the Property are:

- Environmental Assessment of the USX Corporation National and Duquesne Plants by Duncan, Lagnese, and Associates, Inc. (DLA) in May 1988;
- Groundwater Contamination Study, Final Report by DLA in October 1988;
- Groundwater Quality Assessment Summary Report by ICF Kaiser Engineers, Inc. (ICF Kaiser) in August 1993;
- Soil Assessment Program Summary Report by ICF Kaiser in January 1997;
- Remedial Investigation, Baseline Risk Assessment, and Cleanup Plan (RI-RA-CP Report) by KU Resources in June 2000;
- Supplemental Addendum to Remedial Investigation, Baseline Risk Assessment, and Cleanup Plan by KU Resources in January 2001; and
- Cleanup Plan Addendum by KU Resources in May 2012.

According to the 2000 RI-RA-CP Report, constituents detected above the applicable medium-specific concentrations (MSCs) in soil at the Industrial Center of McKeesport included cadmium, iron, lead, mercury, vanadium, benzo(b)fluoranthene, benzo(k)fluoranthene, and methylene chloride. Constituents detected above the applicable MSCs in groundwater were lead, ammonia, naphthalene, and tetrachloroethene. Based on the findings of the RI-RA-CP Report, the additional Phase II assessment activities included the collection of surface and subsurface soil samples at various locations to augment the existing soil quality data for the Property. These soil samples were analyzed for organic constituents only; in order to verify that these constituents are located on the Property. It is assumed from past data that metals are present at the Property, since metal impacts have been documented throughout the Industrial Center of McKeesport property. Organic constituent detections were more isolated.

Any constituents present in soils at the Property would be expected to have originated from facility operations, and entered Property soils at or near the ground surface. For these constituents to enter groundwater, they would have to migrate through the remaining thickness of unsaturated fill via a



TCVC14341CSP E-1

leaching mechanism to a depth of 25 to 30 feet below grade. Any subsequent constituent migration in the groundwater would be to the north, with an ultimate discharge to the Monongahela River.

Groundwater is not currently in use on the Property or adjoining properties. These properties are provided water from the municipal water supplier. Future use of groundwater will be restricted via an environmental covenant. Therefore, further groundwater characterization is not included in this Phase II ESA.

A Site-Specific Sampling and Analysis Plan (SAP) for this Phase II ESA, dated September 2014, was prepared by KU Resources, and submitted to the United States Environmental Protection Agency (U.S. EPA) under its U.S. EPA-sponsored brownfields program. In October 2014, the U.S. EPA indicated that the SAP was acceptable.

As presented in the SAP, a sampling design program was developed and carried out on the Property to verify if organic constituents were present in the soil. The following were incorporated into the sample design:

- Two composite soil samples each were collected from within the 0- to 4-foot depth interval from four excavated trenches (TT-01 through TT-04).
- All of the soil samples were analyzed for Target Compound List (TCL) polychlorinated biphenyls (PCBs) and TCL semi-volatile organic compounds (SVOCs). TCL PCBs were analyzed via laboratory Method 8082A. TCL SVOCs were analyzed via Method 8270D.
- All of the soil samples were field screened with a photoionization device (PID). Since no soil
 samples were above background levels on the PID, none were analyzed for TCL volatile organic
 compounds.

Based upon the laboratory results, screening of all the detected constituents in soil against the applicable non-residential MSCs indicated the following:

- SVOCs: A total of 22 SVOCs were detected in the soil samples above the laboratory detection limit (LDL); however, none of these concentrations exceed the applicable non-residential MSCs.
- PCBs: Two PCBs (PCB 1254 and PCB 1260) were detected in the soil samples above the LDL; however, neither of these two constituents were detected above the applicable non-residential MSCs.

In conclusion, all of the detected SVOC and PCB constituents in TT-01 through TT-04 were at least one order of magnitude below their applicable MSCs.



1.0 INTRODUCTION

A Site-Specific Sampling and Analysis Plan (SAP) for this Phase II Environmental Site Assessment (ESA), dated September 2014, was prepared by KU Resources, Inc. (KU Resources) on behalf of the Turtle Creek Valley Council of Governments (TCVOG) for the East Portion of Parcel 307-D-001, located north of Center Street in McKeesport (Allegheny County), Pennsylvania (i.e., the Property). The SAP was submitted to the United States Environmental Protection Agency (U.S. EPA) in accordance with its brownfields program. In October 2014, the U.S. EPA indicated that the SAP was acceptable.

The objective of this Phase II ESA was to verify if organic constituents were present in the Property soil via an intrusive sampling and analysis program.

This Phase II ESA Report has been developed by KU Resources on behalf of TCVOG for the Property. The findings of the investigation are presented herein and follow the general guidance included in ASTM International's Standard E 1903-11 Standard Practice for Environmental Site Assessments: Phase II Environmental Site Assessment Process.



2.0 BACKGROUND

2.1 Site Description and Features

The Property is a portion of the larger Industrial Center of McKeesport property, located along Lysle Boulevard in McKeesport (Allegheny County), Pennsylvania. The Property encompasses approximately 1 acre of land. No structures are currently located on the Property. The Property is recorded in the Allegheny County Tax Assessment as the east portion of Parcel 0307-D-00001-0000-00. Figure 2-1 identifies the Property location on a U.S. Geological Survey Quadrangle map. Figure 2-2 provides a Property Layout Map, including the Property boundaries and the Phase II ESA sampling locations.

2.2 Physical Setting

The Property is situated on the north side of Center Street, and commercial/light industrial properties surround the Property to the west, east, and south. The north boundary of the Property is bordered by the bicycle trail and railroad tracks. The nearest surface water (Monongahela River) is located immediately beyond the railroad tracks to the north of the Property. The Property is generally topographically level. A small gravel area is located on the west portion of the Property. The remaining portions of the Property are vegetated.

2.3 Site History and Land Use

As presented in the Groundwater Quality Assessment Summary Report (ICF Kaiser, 1993), the history of the Industrial Center of McKeesport dates back to 1870, when the Flagler Company purchased the partially rebuilt works of the Fulton-Bolman Company in McKeesport. Shortly thereafter, the Flagler Company became incorporated as the National Tube Works. In 1899, the 13 major tube and pipe producers, including the National Tube Works, were consolidated and named the National Tube Company. On March 1, 1901, the National Tube Company became a subsidiary of United States Steel Corporation (USS). Although the National Tube Works never included a coke plant, it served as the "mother plant" of the USS Eastern Steel Operations' tubular products section for the next 80 years.

Throughout the 1900s, the National Tube Works produced steel tube and pipe of varying sizes and characteristics. In 1969, the National Tube Works merged with the USS Duquesne Works located across the Monongahela River. Following this merger, many of the operations at the National Tube Works were shut down, including the closing of the open hearth, blooming mill, rolling mill, and all but one of the blast furnaces. Figure 2-3 shows the mill operations on the Property as they appeared in the 1980s. Specifically, the Property formerly consisted of the Laddle Repair Building and a portion of the Blowing Room structure.

In 1987, the National Tube Works shut down, and ownership was transferred to Allegheny County in 1989. In 1990, the Allegheny County Industrial Development Authority transferred ownership of the 135-acre site to the RIDC Growth Fund. In an effort to revitalize the City of McKeesport, create jobs, and promote economic growth, the RIDC Growth Fund began preparing the site for redevelopment as an industrial park. This ongoing effort has included the following:



- Removal and off-site disposal of polychlorinated biphenyls (PCBs) and PCB-contaminated electrical equipment;
- Removal, decontamination, and off-site disposal of materials from tanks, vessels, equipment, and piping;
- Asbestos abatement;
- Staging, removal, transportation, and off-site disposal of approximately 2000 drums;
- Removal of eight underground storage tanks;
- Remediation of over 100 concrete pits and sumps;
- Removal, transportation, and off-site disposal of waste piles;
- Renovation of selected existing buildings and portions of buildings;
- Demolition of various buildings not suited for renovation;
- Construction of new infrastructure;
- Construction of a new building housing an industrial operation near the main entrance of the facility; and
- Refurbishment of a portion of the McKeesport Commons facility.

In 1993, the Industrial Center of McKeesport was designated as a General Industrial District by the City of McKeesport. The subdivided parcels within the Industrial Center of McKeesport are, therefore, permitted for uses such as manufacturing, printing and publishing, warehouse/storage, vehicle repair, and railroad or truck terminals. Other conditional uses for which the land has been approved include research and development, testing laboratories, and warehouse/storage facilities for hazardous materials.

2.4 Adjacent Property Land Use

The adjacent properties are a mix of various land uses, as follows:

- North: bicycle trail, railroad tracks, Monongahela River;
- <u>South</u>: Center Street, beyond which is Steel City Products (automotive supply manufacturing and distribution center);
- <u>East</u>: Consolidated Power Supply (commercial business that sells nuclear certified products);
 and
- West: former railroad roundhouse structure currently unoccupied.

The past uses of the adjoining properties were all included in the history of the Industrial Center of McKeesport but, more specifically, the adjoining properties were occupied by the following structures:

- North: pump station and railroad tracks;
- South: train turntables and blast furnaces;
- East: sub-station, electric repair shop, bar mill, and billet peelers; and
- West: railroad roundhouse.



2.5 Previous Assessments

The historical site characterization reports that included the Property are:

- Environmental Assessment of the USX Corporation National and Duquesne Plants by Duncan, Lagnese, and Associates, Inc. (DLA) in May 1988;
- Groundwater Contamination Study, Final Report by DLA in October 1988;
- Groundwater Quality Assessment Summary Report by ICF Kaiser Engineers, Inc. (ICF Kaiser) in August 1993;
- Soil Assessment Program Summary Report by ICF Kaiser in January 1997;
- Remedial Investigation, Baseline Risk Assessment, and Cleanup Plan (RI-RA-CP Report) by KU Resources in June 2000:
- Supplemental Addendum to Remedial Investigation, Baseline Risk Assessment, and Cleanup Plan by KU Resources in January 2001; and
- Cleanup Plan Addendum by KU Resources in May 2012.

A Final Report and Environmental Covenant were submitted and approved for the Industrial Center of McKeesport in October 2013 and May 2014; however, Parcel 307-D-001 (containing the Property) was not included in these documents. Previous documents are included on a CD as Appendix A.

2.5.1 Conclusions of the Previous Reports

According to the 2000 RI-RA-CP Report, newly acquired site data and physical information were compiled with the previously-collected information and compared with the Pennsylvania's Land Recycling and Environmental Remediation Standards Act (Act 2) Statewide Health Standard Medium-Specific Concentrations (MSCs). A conceptual site model was then developed, constituents of concern (COCs) in soil and groundwater were identified, five exposure pathways of interest were identified, and pathway elimination approaches were developed to address four of the five identified exposure pathways of interest. These pathway elimination approaches included waste removal activities, pavement and vegetated soil covers, and groundwater use restrictions. The remaining exposure pathway of interest that could not be addressed by pathway elimination was the groundwater to surface water pathway. The RA evaluated this pathway and demonstrated that estimated in-stream concentrations were well below the Pennsylvania surface water quality criteria for both aquatic life and human health. No further action was required for this pathway. The ecological receptor evaluation concluded that no potentially viable habitats for ecological receptors are located on the property due to site development and physical conditions.

Identified COCs on the Industrial Center of McKeesport property included the following:

- Soil
 - Benzo(b)fluoranthene,
 - Benzo(k)fluoranthene,
 - o Cadmium,
 - o Iron,
 - o Lead,
 - Mercury,



- o Methylene Chloride, and
- o Vanadium.

Groundwater

- o Ammonia,
- o Lead,
- o Naphthalene, and
- o Tetrachloroethene (PCE).



3.0 WORK PERFORMED AND RATIONALE

3.1 Conceptual Site Model

The potential for adverse risks to arise from contact with constituents in an environmental medium is based on the following four factors: 1) chemicals must be present at hazardous levels, 2) an environmental medium must be present to receive or transport the chemicals, 3) receptors must be present, and 4) exposure pathways must exist between the source of the chemicals and receptors. In the absence of any one of the four components, risks do not exist. The presence of all four elements indicates a potential for risks to human health, but does not necessarily indicate an unacceptable risk.

Development of a conceptual site model is a critical step in the Phase II ESA process to identify the potential sources of constituents, the release mechanisms into environmental media, and potential exposure pathways and receptors.

3.1.1 Target Analytes

According to the 2000 RI-RA-CP Report, constituents detected above the applicable MSCs in soil at the Industrial Center of McKeesport included cadmium, iron, lead, mercury, vanadium, benzo(b)fluoranthene, benzo(k)fluoranthene, and methylene chloride. Constituents detected above the applicable MSCs in groundwater were lead, ammonia, naphthalene, and PCE. Based on the findings of the RI-RA-CP Report, the additional Phase II assessment SAP activities included the collection of surface and subsurface soil samples at various locations to augment the existing soil quality data for the Property. These soil samples were analyzed for organic constituents only; in order to verify that these constituents are located on the Property. It is assumed from past data that metals are present at the Property, since metal impacts have been documented throughout the Industrial Center of McKeesport property. Organic constituent detections were more isolated.

3.1.2 Pathways of Interest

Information regarding Property hydrogeology indicates that there is a relatively thick unsaturated zone present across the Property, with groundwater levels occurring at depths of 25 to 30 feet. The upper unit is predominantly composed of slag fill, with minor occurrences of other fill materials such as brick, sand, and soil.

There is no evidence suggesting the disposal of chemical waste materials during the placement of this fill unit. Any constituents present in soils at the Property would, therefore, be expected to have originated from facility operations, and entered Property soils at or near the ground surface. For these constituents to enter groundwater, they would have to migrate through the remaining thickness of unsaturated fill via a leaching mechanism to a depth of 25 to 30 feet below grade. Any subsequent constituent migration in the groundwater would be to the north, with an ultimate discharge to the Monongahela River.

In a typical setting, multiple migration pathways exist that create the potential for contact between chemical constituents and receptors. These pathways include direct ingestion, inhalation, or dermal contact with soil and/or groundwater. Constituents may also migrate through the soil to groundwater, and



groundwater may migrate to surface water. Finally, vapors from contaminants present in soil and/or groundwater may migrate upwards to the surface, creating an indoor air exposure pathway. Pennsylvania regulations allow a remediator to eliminate potential migration exposure pathways where it can be demonstrated that the pathway either does not exist or results in acceptable exposure levels based upon current guidance or regulations.

Groundwater is not currently in use on the Property or adjoining properties. These properties are provided water from the municipal water supplier. Future use of groundwater will be restricted via an environmental covenant. Therefore, further groundwater characterization is not included in this Phase II ESA.

3.2 Scope of Assessment

Field activities were implemented as presented in the SAP (KU Resources, 2014). A Health and Safety Plan was prepared for use with all field sampling activities. The soil investigation included collecting soil samples from four excavated trenches (within the 0- to 4-foot depth interval). Groundwater samples were not collected. All field activities occurred on November 3, 2014.

3.3 Exploration, Sampling, and Test Screening Methods

3.3.1 Trench Excavations

Four test trenches (TT-01 through TT-04) were excavated using a backhoe vehicle on the Property. These trenches were located in the four cardinal quadrangles of the Property (north, south, east, and west). These trenches overlapped slightly to ensure that the entire Property was covered. The trenches were excavated to 4 feet below ground surface or equipment refusal/bedrock; whichever occurred first.

Field notes were recorded as the test trenches were excavated on the Property. A typed version of these notes is included in Appendix B. Depth of the trenches and approximate length of each depth was recorded. Photographs were also taken during the trenching activities (see Appendix C). The test trench locations are included on Figure 2-2, Property Layout Map.

3.3.2 Soil Sampling

Soil samples were collected as composite samples from the 0- to 4-foot depth interval from the four excavated trenches. Two composite samples were collected from each trench for a total of eight soil samples. Suspect material (material with visible and/or odorous indications of soil quality impacts) was not found during the trenching activities; and, therefore, was not sampled.

All samples were examined in the field, and field logs noting soil and lithologic descriptions, environmental quality observations, and other pertinent information were maintained. The soil samples were field screened with a photoionization device (PID) equipped with a 10.6 electron volt (eV) lamp. The soil samples were placed into air-tight zipped baggies, following excavation. Screening of these samples occurred immediately after opening each baggie. The results of the field screening were recorded as a parts-per-million concentration in the field logbook. According to the PID results, none of the soil samples were found above background levels.



Samples were then transferred to sample containers for laboratory analysis. The soil samples were submitted to a certified laboratory for analysis. Filled sample containers were placed on ice in an insulated cooler pending completion of the day's sampling activities. Samples were packaged for delivery to the laboratory at the completion of the working day, ensuring that the samples remained cool (approximately 4° C) until logged in by the laboratory. The shipping containers were accompanied by a completed lab-supplied chain-of-custody form. All of the soil samples were analyzed for Target Compound List (TCL) PCBs and TCL semi-volatile organic compounds (SVOCs). Trenches were backfilled upon completion of the sampling.

3.4 Chemical Analytical Methods

As presented in the 2014 SAP, a sampling design program was developed and carried out on the Property to verify if organic constituents were present in the soil. The following were incorporated into the sample design:

- Two composite soil samples each were collected from within the 0- to 4-foot depth interval from the four excavated trenches.
- All of the soil samples were analyzed for TCL PCBs and TCL SVOCs. TCL PCBs were analyzed via laboratory Method 8082A. TCL SVOCs were analyzed via Method 8270D.
- All of the soil samples were field screened with a PID. Since no soil samples were above background levels on the PID, none were analyzed for TCL volatile organic compounds.

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4.0 PRESENTATION AND EVALUATION OF RESULTS

4.1 Subsurface Conditions

Please refer to Figure 2-1 that illustrates the location of the Site on a U.S. Geological Survey 7.5-minute topographic map. Regional and site geology and hydrogeology were discussed by both DLA (1988a, 1988b) and ICF Kaiser (1993).

4.1.1 Geological Setting

According to DLA and ICF Kaiser, at the Industrial Center of McKeesport property (including the Property), a surficial fill unit is present that is comprised primarily of poorly sorted slag ranging to cobble size. This unit ranges to as much as 35 feet thick. The natural soil underlying the slag fill generally consists of layers of sand and silty clay, interspersed with gravel. This unit is present to depths of up to 80 feet. The upper bedrock, encountered at a depth of 80 feet, was reported to be a red-gray clay shale.

4.1.2 Hydrogeological Conditions

Based on water levels in the monitoring wells installed by DLA and ICF Kaiser, it was determined that the first water-bearing unit present in the unconsolidated materials (slag fill and natural soils) at the Industrial Center of McKeesport property is continuous to the bedrock surface, and that groundwater flow is north, to the Monongahela River. Water levels were generally found between depths of 25 to 30 feet below grade. Groundwater velocities were estimated to be between 1 and 10 feet per year.

4.2 Evaluation of Analytical Data

4.2.1 Data Validation

The Quality Assurance Project Plan (Section D) provides the data validation and usability protocols and how the overall Data Quality Objectives for this project will be met by verifying the methods and results to collect, develop, and report the data.

Any issues associated with data usability were resolved through the consultant's experience with the protocols and limitations associated with Pennsylvania's Act 2. Any limitations on the use of the data were conveyed to the decision makers through periodic program updates, as well as within this Phase II Assessment report which documents the implementation of the SAP.

4.2.2 Soil Results

Soil samples were collected from the depth intervals of 0 to 4 feet from the four test trenches (TT-01 through TT-04). The soil data was compared to the Pennsylvania's Act 2 MSCs for non-residential soils. A summary of soil analytical results with detected constituents is provided as Table 4-1. Low levels of organics were detected in the soil samples. Laboratory analytical results are included in Appendix D.

Screening of all the soil results against the applicable non-residential MSCs indicated the following:



- SVOCs: A total of 22 SVOCs were detected in the soil samples above the laboratory detection limit (LDL); however, none of these concentrations exceed the applicable non-residential MSCs.
- PCBs: Two PCBs (PCB 1254 and PCB 1260) were detected in the soil samples above the LDL; however, neither of these two constituents were detected above the applicable non-residential MSCs.



5.0 CONCLUSIONS

In conclusion, all of the detected SVOC and PCB constituents in TT-01 through TT-04 were at least one order of magnitude below their applicable MSCs. It is assumed from previous data on the Industrial Center of McKeesport property that metals are present at the Property.



6.0 REFERENCES

ASTM International, 2011. "Standard Practice for Environmental Site Assessments: Phase II Environmental Site Assessment Process." Designation: E1903-11. July 2011.

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TABLE



Table 4-1: Detected Constituents in Soil Samples from Test Trenches
East Portion of Parcel 307-D-1, McKeesport, PA

	Sa	ample ID	TT-01	Α	TT-01	В	TT-02	Α	TT-02	В	TT-03	A	TT-03	3	TT-04	1	TT-04I	3
	Sample Date Depth (ft-bgs)		11/3/2014		11/3/2014 (0-4')													
Constituents	MSC ⁽¹⁾	MSC ⁽²⁾																
SVOCs (mg/kg)																		
Acenaphthene	170,000	4,700	0.025	J	0.022	J	0.031	J	0.032	J	0.03	J	0.035	J	0.043	J	0.027	J
Acenaphthylene	170,000	6,900	0.099		0.043	J	0.15		0.23		0.18		0.26		0.11		0.21	
Anthracene	190,000	350	0.11		0.096		0.24		0.22		0.23		0.31		0.23		0.25	
Benzo(a)anthracene	110	320	0.59		0.66		0.7		0.8		0.72		1.4		0.95		0.96	
Benzo(a)pyrene	11	46	0.56		0.61		0.62		8.0		0.67		1.4		1.1		0.74	
Benzo(b)fluoranthene	110	170	0.83		0.92		0.74		1.1		0.97		2		1.3		1.2	
Benzo(g,h,i)perylene	170,000	180	0.58		0.51		0.58		0.78		0.66		1.7		1.1		0.84	
Benzo(k)fluoranthene	1,100	610	0.39		0.31		0.39		0.39		0.35		0.62		0.55		0.45	
Biphenyl, 1,1	140,000	2,200	0.37	U	0.37	U	0.73	U	0.75	U	0.38	U	0.38	U		U	0.044	J
Bis(2-ethylhexyl)phthalate	5,700	130	0.76	U	0.75	U	1.5	U	1.5	U	0.77	U	0.77	U	0.16	J	0.75	U
Carbazole	4,000	83	0.044	J	0.065	J	0.089	J	0.077	J	0.063	J	0.069	J	0.11		0.11	
Chrysene	11,000	230	0.7		0.71		0.65		0.86		0.77		1.5		1		0.88	
Dibenzo(a,h)anthracene	11	160	0.12		0.11		0.17		0.13	J	0.19		0.43		0.28		0.21	
Dibenzofuran	2,800	260	0.06	J	0.051	J	0.11	J	0.11	J	0.11	J	0.083	J	0.092	J	0.16	J
Diethyl phthalate	10,000	8,200	0.12	J	0.37	U	0.73	U	0.75	U	0.38	U	0.07	J	0.041	J	0.043	J
Fluoranthene	110,000	3,200	0.93		8.0		1		1.3		1.3		1.8		1.5		1.4	
Fluorene	110,000	3,800	0.029	J	0.029	J	0.1	J	0.045	J	0.043	J	0.049	J	0.086		0.085	
Indeno(1,2,3-cd)pyrene	110	28,000	0.47		0.42		0.56		0.71		0.61		1.4		0.87		0.7	
2-Methylnaphthalene	11,000	1,600	0.074	J	0.081		0.12	J	0.16		0.17		0.14		0.084		0.14	
Naphthalene	56,000	25	0.16		0.11		0.12	J	0.12	J	0.22		0.16		0.16		0.33	
Phenanthrene	190,000	10,000	0.45		0.55		0.67		0.65		0.75		0.65		0.92		0.99	
Pyrene	84,000	2,200	8.0		0.97		0.84		1.1		0.95		1.9		1.2		1.1	
PCBs (mg/kg)																		
PCB-1254	40	260	0.57		0.57		0.091		0.68		0.24		0.085		0.021		1.3	
PCB-1260	40	590	0.097		0.11		0.068		0.26		0.12		0.099		0.033		0.22	

MSC: Medium-Specific Concentration.

mg/kg: millogram per kilogram.

Shaded: Exceeds Direct Contact MSC.
Bolded: Exceeds Soil-to-Groundwater MSC.

U: Non-detect.

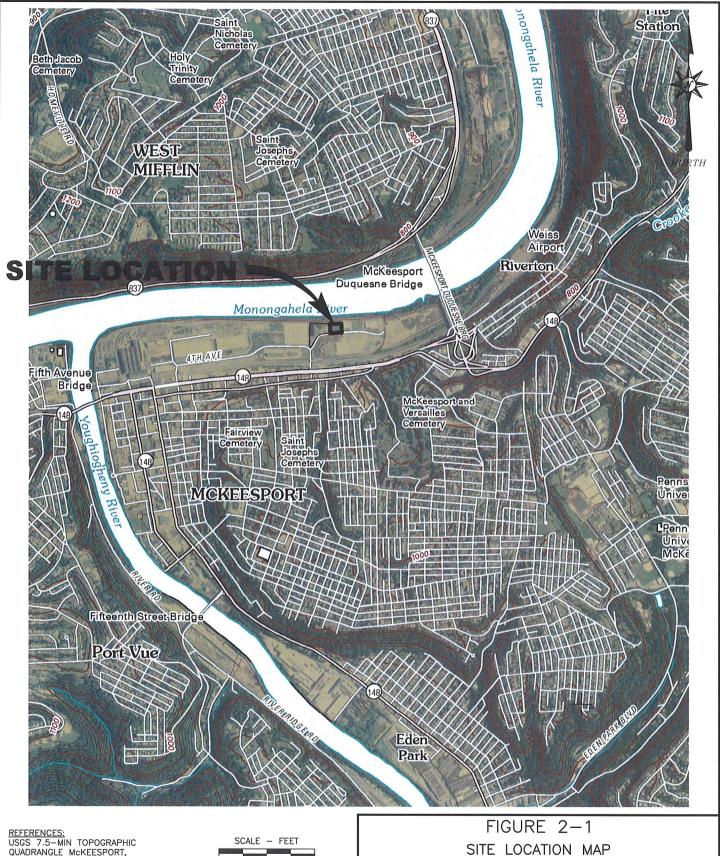
J: Lab estimate.

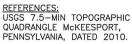
^{(1):} PADEP Direct Contact, Used Aquifer, non-residential.

^{(2):} PADEP Soil-to-Groundwater, Used Aquifer, non-residential.

FIGURES









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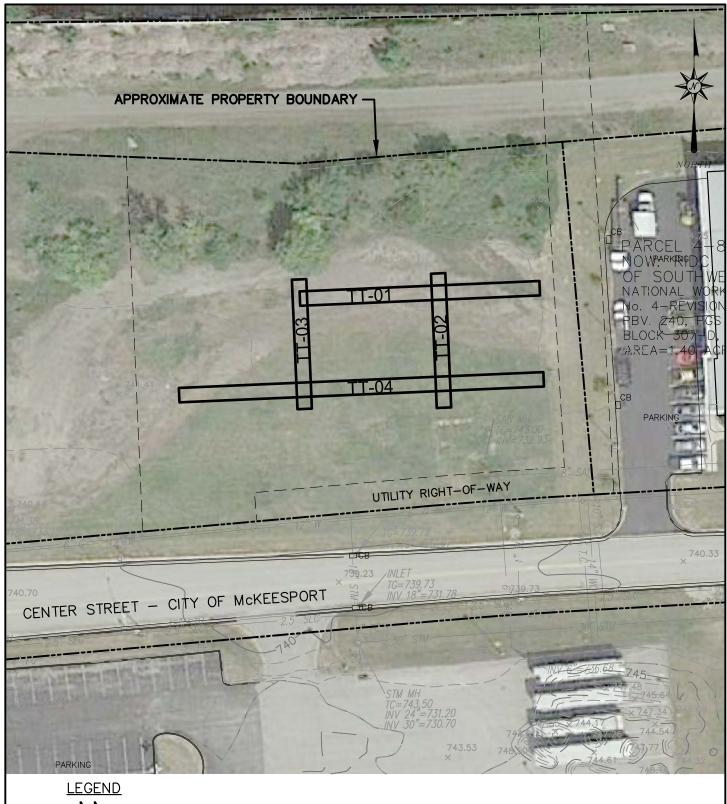
KU Resources. Inc. 22 South Linden Street Duquesne, PA 15110 412.469.9331 412.469.9336 fax www.kuresources.com

DESCRIPTION

INDUSTRIAL CENTER OF McKEESPORT EAST PORTION OF PARCEL 307-D-001 CITY OF McKEESPORT ALLEGHENY COUNTY, PENNSYLVANIA

PREPARED FOR

TURTLE CREEK VALLEY COUNCIL OF GOVERNMENTS MONROEVILLE, PENNSYLVANIA





REFERENCES: SURVEY MAPPING PROVIDED BY SENATE ENGINEERING DRAWING NUMBER D5189, DATED 10/28/2009. IMAGE BY GOOGLE EARTH



APPROVED MRU 09/25/2014
CHECKED SBU 09/25/2014
DRAWN RAM 09/25/2014
CAD FILE NO. 14341A005
PROJECT NO. TCVC 14341 CSP



KU Resources, Inc.

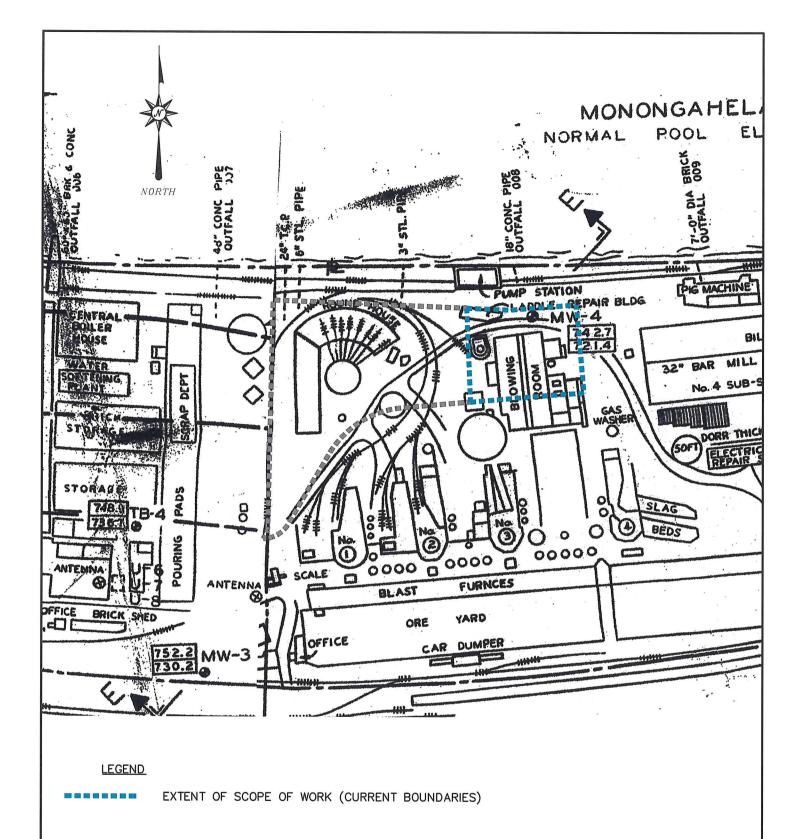
22 South Linden Street Duquesne, PA 15110 412.469.9331 412.469.9336 fax www.kuresources.com

FIGURE 2-2

PROPERTY LAYOUT MAP
INDUSTRIAL CENTER OF McKEESPORT
EAST PORTION OF PARCEL 307-D-001
CITY OF McKEESPORT
ALLEGHENY COUNTY, PENNSYLVANIA

PREPARED FOR

TURTLE CREEK VALLEY
COUNCIL OF GOVERNMENTS
MONROEVILLE, PENNSYLVANIA



REFERENCE:
PROJECT NO. 2U024.00, DRAWING 6 OF
10, FIGURE 2-2, MILL OPERATIONS IN
THE 1980s, BY DUNCAN, LAGNESE AND ASSOCIATES, INCORPORATED, PITTSBURGH, PA, DATED DEC. 31, 1987, REVISED 3/16/88.



APPROVED	MRU	09/25/2014
CHECKED	SBU	09/25/2014
DRAWN	RAM	09/25/2014
CAD FILE NO.		14341A003
PROJECT NO.	TCV	C 14341 CSP



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22 South Linden Street Duquesne, PA 15110 412.469.9331 412.469.9336 fax www.kuresources.com

FIGURE 2-3

HISTORIC OPERATIONS INDUSTRIAL CENTER OF McKEESPORT EAST PORTION OF PARCEL 307-D-001 CITY OF McKEESPORT ALLEGHENY COUNTY, PENNSYLVANIA

PREPARED FOR

TURTLE CREEK VALLEY COUNCIL OF GOVERNMENTS MONROEVILLE, PENNSYLVANIA

APPENDICES



Appendix A
Previous Reports
[Provided on CD]



SITE-SPECIFIC SAMPLING AND ANALYSIS PLAN ADDITONAL PHASE II ASSESSMENT ACTIVITIES EAST PORTION OF PARCEL 307-D-001 NORTH OF CENTER STREET MCKEESPORT, PENNSYLVANIA

Prepared for:
TURTLE CREEK VALLEY COUNCIL OF GOVERNMENTS
2700 MONROEVILLE BOULEVARD
MONROEVILLE, PENNSYLVANIA 15146

SEPTEMBER 2014



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FIGURES

Figure 1 Site Location Map

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APPENDIX

Appendix A Standard Operating Procedures*

*Appendix provided on CD.



Title and Approval Page

Site-Specific Sampling and Analysis Plan Additional Phase II Assessment Activities East Portion of Parcel 307-D-001 North of Center Street McKeesport, Pennsylvania

Prepared by:
KU Resources, Inc.
22 South Linden Street
Duquesne, Pennsylvania 15110
412-469-9331

September 2014

Cooperative Agreement Recipient: Amanda Settelmain
Signature
Amanda Settelmaier
Printed Name/Date
Printed Name/Date Project Quality Assurance Officer:
Signature
Sara Uhl, Project Scientist II
Printed Name/Date
U.S. EPA Project Manager:
Signature
Humberto Monsalvo
Printed Name/Date



Distribution List

Amanda Settelmaier Turtle Creek Valley Council of Governments 2700 Monroeville Boulevard Monroeville, PA 15146

Daniel Sharek Regional Industrial Development Corporation of Southwestern Pennsylvania 210 Sixth Avenue, Suite 3620 Pittsburgh, PA 15222

Mark Urbassik, P.E., Principal Mark Patrick, Grant Administrator Sara Uhl, Project Manager/QA Officer KU Resources, Inc. 22 South Linden Street Duguesne, PA 15110

Humberto J. Monsalvo, Jr. (3HS23) U.S. Environmental Protection Agency Region 3 1650 Arch Street Philadelphia, PA 19103



SITE-SPECIFIC SAMPLING AND ANALYSIS PLAN ADDITIONAL PHASE II ASSESSMENT ACTIVITIES EAST PORTION OF PARCEL 307-D-001 MCKEESPORT, PENNSYLVANIA SEPTEMBER 2014 PAGE 1

INTRODUCTION

This site-specific Sampling and Analysis Plan (SAP) has been prepared on behalf of the Turtle Creek Valley Council of Governments (TCVOG) to define the scope of the additional Phase II assessment activities for the East Portion of Parcel 307-D-001 located north of Center Street in McKeesport (Allegheny County), Pennsylvania (the "Site"). Figure 1 identifies the Site location on a U.S. Geological Survey Quadrangle map.

This Site-specific SAP serves as a companion document to the "Turtle Creek Valley Council of Governments, Programmatic Quality Assurance Project Plan (QAPP), Phase I and Phase II Environmental Site Assessments, Multiple Properties, Allegheny County, Pennsylvania" (KU Resources, Inc., May 2013) previously approved by the U.S. Environmental Protection Agency (U.S. EPA). This Site-specific SAP identifies the specific procedures to be followed during the implementation of the additional Phase II assessment activities to facilitate the production of representative and valid data during the investigative activities at the Site.

In accordance with the Programmatic QAPP, the format of this Site-specific SAP is consistent with the *U.S. EPA Region III Site-Specific Sampling and Analysis Plan Template, Draft Interim Final,* dated August 1999. Pursuant to this guidance document, the following technical elements are included within this SAP:

- Project Management (Sections A.1 through A.4);
- Measurement/Data Acquisition (Sections B.1 through B.4);
- Assessment and Oversight (Sections C.1 through C.2); and
- Data Validation and Usability (Section D).

Standard Operating Procedures (SOPs) for Phase II ESA field investigations were incorporated as Attachment A of the previously approved QAPP. This SAP will be conducted in accordance with a site-specific health and safety plan (HASP) and will follow in general accordance with the ASTM International Standards (ASTM, 2013).



A. PROJECT MANAGEMENT

A.1 Site Information/Background

A.1.1 Background/Objectives

The Site was identified by TCVOG as a brownfields site with both viable redevelopment potential, and some degree of potential environmental concerns which warranted assessment. The Site is being assessed under its U.S. EPA-sponsored brownfields program for potential environmental liabilities associated with the Site prior to owner redevelopment of the property or a third party potentially becoming an owner or operator of the Site through purchase, acquisition, lease, renovation, or development of the land or buildings at this location.

The objective of this SAP is to verify if organic constituents are present in the Site soil via an intrusive sampling and analysis program.

A.1.2 Relevant Site Characteristics

A.1.2.1 Property Description

The Site is a portion of the larger Industrial Center of McKeesport property, located along Lysle Boulevard in McKeesport (Allegheny County), Pennsylvania. The Site encompasses approximately 1 acre of land. The Site is recorded in the Allegheny County Tax Assessment as the east portion of Parcel 0307-D-00001-0000-00. Figure 2 provides an aerial photograph of the Site layout.

The Site is situated on the north side of Center Street, and commercial/light industrial properties surround the Site. Access to the Site is via Center Street to the south. The north boundary of the Site is bordered by the bicycle trail and railroad tracks. The Site is generally topographically level. The nearest surface water (Monongahela River) is located immediately beyond the railroad tracks to the north of the Site.

No structures are located on the Site. A gravel area is located in the center portion of the Site. The remaining portions are vegetated.

A.1.2.2 Current Uses of the Property

The Site is currently a vacant, industrial property. The Regional Industrial Development Corporation of Southwestern Pennsylvania Growth Fund (RIDC Growth Fund), represented by Mr. Daniel Sharek, currently owns the Site. The west portion of Parcel 307-D-001 (not included in the Site area) consists of a former railroad roundhouse structure, which is currently unoccupied.

Direct utility service is not currently provided to the Site. However, electric, natural gas, and city water and sanitary appear to be available to nearby properties.



A.1.2.3 Past Uses of the Property

As presented in the Groundwater Quality Assessment Summary Report (ICF Kaiser, 1993), the history of the Industrial Center of McKeesport dates back to 1870, when the Flagler Company purchased the partially rebuilt works of the Fulton-Bolman Company in McKeesport. Shortly thereafter, the Flagler Company became incorporated as the National Tube Works. In 1899, the 13 major tube and pipe producers, including the National Tube Works, were consolidated and named the National Tube Company. On March 1, 1901, the National Tube Works became a subsidiary of the United States Steel Corporation (USS). Although the National Tube Works never included a coke plant, it served as the "mother plant" of the USS Eastern Steel Operations' tubular products section for the next 80 years.

Throughout the 1900s, the National Tube Works produced steel tube and pipe of varying sizes and characteristics. In 1969, the National Tube Works merged with the USS Duquesne Works located across the Monongahela River. Following this merger, many of the operations at the National Tube Works were shut down, including the closing of the open hearth, blooming mill, rolling mill, and all but one of the blast furnaces. Figure 3 shows the mill operations on the Site as they appeared in the 1980s. Specifically, the Site formerly consisted of the Laddle Repair Building and a portion of the Blowing Room structure.

In 1987, the National Tube Works shut down, and ownership was transferred to Allegheny County in 1989. In 1990, the Allegheny County Industrial Development Authority transferred ownership of the 135-acre site to the RIDC Growth Fund. In an effort to revitalize the City of McKeesport, create jobs, and promote economic growth, the RIDC Growth Fund began preparing the site for redevelopment as an industrial park. This ongoing effort has included the following:

- Removal and off-site disposal of polychlorinated biphenyls (PCBs) and PCB-contaminated electrical equipment;
- Removal, decontamination, and off-site disposal of materials from tanks, vessels, equipment, and piping;
- Asbestos abatement;
- Staging, removal, transportation, and off-site disposal of approximately 2000 drums;
- Removal of eight underground storage tanks;
- Remediation of over 100 concrete pits and sumps;
- Removal, transportation, and off-site disposal of waste piles;
- Renovation of selected existing buildings and portions of buildings;
- Demolition of various buildings not suited for renovation;
- Construction of new infrastructure;
- Construction of a new building housing an industrial operation near the main entrance of the facility; and
- Refurbishment of a portion of the McKeesport Commons facility for use by Echostar.



SITE-SPECIFIC SAMPLING AND ANALYSIS PLAN ADDITIONAL PHASE II ASSESSMENT ACTIVITIES EAST PORTION OF PARCEL 307-D-001 MCKEESPORT, PENNSYLVANIA SEPTEMBER 2014 PAGE 4

In 1993, the property was designated as a General Industrial District by the City of McKeesport. The subdivided parcels within the Industrial Center of McKeesport are, therefore, permitted for uses such as manufacturing, printing and publishing, warehouse/storage, vehicle repair, and railroad or truck terminals. Other conditional uses for which the land has been approved include research and development, testing laboratories, and warehouse/storage facilities for hazardous materials.

A.1.2.4 Current/Past Uses of Adjoining Properties

Current Uses

The current uses of the adjoining properties include the following:

- North: bicycle trail, railroad tracks, Monongahela River;
- <u>South</u>: Center Street, beyond which is Steel City Products (automotive supply manufacturing and distribution center);
- <u>East</u>: Consolidated Power Supply (commercial business that sells nuclear certified products);
 and
- West: former railroad roundhouse structure currently unoccupied.

Past Uses

The past uses of the adjoining properties were all included in the history of the Industrial Center of McKeesport (Section A.1.2.3) but, more specifically, the adjoining properties were occupied by the following structures:

- North: pump station and railroad tracks;
- South: train turn-tables and blast furnaces;
- East: sub-station, electric repair shop, bar mill, and billet peelers; and
- West: railroad roundhouse.

A.1.2.5 Historical Site Characterization

The historical site characterization reports that included the Site are:

- Environmental Assessment of the USX Corporation National and Duquesne Plants by Duncan, Lagnese, and Associates, Inc. (DLA) in May 1988;
- Groundwater Contamination Study, Final Report by DLA in October 1988;
- Groundwater Quality Assessment Summary Report by ICF Kaiser Engineers, Inc. (ICF Kaiser) in August 1993;
- Soil Assessment Program Summary Report by ICF Kaiser in January 1997;



- Remedial Investigation, Baseline Risk Assessment, and Cleanup Plan (RI-RA-CP Report) by KU Resources in June 2000;
- Supplemental Addendum to Remedial Investigation, Baseline Risk Assessment, and Cleanup Plan by KU Resources in January 2001; and
- Cleanup Plan Addendum by KU Resources in May 2012.

A Final Report and Environmental Covenant were submitted and approved for the Industrial Center of McKeesport in October 2013 and May 2014; however, Parcel 307-D-001 (including the Site) was not included in these documents.

A.1.2.6 Physical Setting

Please refer to Figure 1 that illustrates the location of the Site on a U.S. Geological Survey 7.5-minute topographic map. Regional and site geology and hydrogeology were discussed by both DLA (1988a, 1988b) and ICF Kaiser (1993).

Site Geology

According to DLA and ICF Kaiser, at the Industrial Center of McKeesport property (includes the Site), a surficial fill unt is present that is comprised primarily of poorly sorted slag ranging to cobble size. This unit ranges to as much as 35 feet thick. The natural soil underlying the slag fill generally consists of layers of sand and silty clay, interspersed with gravel. This unit is present to depths of up to 80 feet. The upper bedrock, encountered at a depth of 80 feet, was reported to be a red-gray clay shale.

Groundwater

Based on water levels in the monitoring wells installed by DLA and ICF Kaiser, it was determined that the aquifer present in the unconsolidated materials (slag fill and natural soils) at the Industrial Center of McKeesport property is continuous to the bedrock surface, and that groundwater flow is north, to the Monongahela River. Water levels were generally found between depths of 25 to 30 feet below grade. Groundwater velocities were estimated to be between 1 and 10 feet per year.

A.1.2.7 Conclusions of the Previous Reports

According to the 2000 RI-RA-CP Report, newly acquired Site data and physical Site information were compiled with the previously-collected information and compared with the Pennsylvania Act 2 Statewide Health Standard Medium Specific Concentrations (MSCs). A conceptual site model was then developed, constituents of concern (COCs) in soil and groundwater were identified, five exposure pathways of interest were identified, and pathway elimination approaches were developed to address four of the five identified exposure pathways of interest. These pathway elimination approaches included waste removal activities, pavement and vegetated soil covers, and groundwater use restrictions. The remaining exposure pathway of interest that could not be addressed by pathway elimination was the groundwater to surface water pathway. The RA evaluated this pathway and demonstrated that estimated in-stream concentrations were well below the Pennsylvania surface water quality criteria for both aquatic life and human health. No further action was required for this pathway. The ecological receptor evaluation



concluded that no potentially viable habitats for ecological receptors are located on the property due to site development and physical conditions.

Identified COCs on the Industrial Center of McKeesport property included the following:

- Soil:
 - o Benzo(b)fluoranthene,
 - o Benzo(k)fluoranthene,
 - o Cadmium,
 - o Iron.
 - o Lead,
 - o Mercury,
 - Methylene Chloride, and
 - Vanadium.

Groundwater:

- o Ammonia,
- o Lead.
- o Naphthalene, and
- Tetrachloroethene (PCE).

A.2 Project Description

A.2.1 Description of Work to be Performed

Based on the findings of the previous reports, the additional Phase II assessment activities will include the collection of surface and subsurface soil samples at various locations to assess soil quality at the Site. Specific sample design and methodology are provided within Section B of this Site-specific SAP.

A.2.2 Applicable or Relevant and Appropriate Requirements

The primary Applicable or Relevant and Appropriate Requirement for brownfield site assessments in Pennsylvania is the Pennsylvania Land Recycling and Environmental Remediation Standards Act. This voluntary state regulatory program, commonly referred to as Pennsylvania's Act 2, was developed to address the environmental problems associated with unused and abandoned industrial sites within the Commonwealth. Act 2 was enacted in May 1995 and provides for the following:

- The Recycling of Existing Industrial and Commercial Sites
 - Minimizes Greenfield Development
 - Promotes the Reuse of Sites in Economically Impacted Areas
- Defines Cleanup Liability



- Sets Obtainable Standards Protective of the Environment
- Promotes Voluntary Cleanup Activity
- Establishes a Framework for Remediation Standards
 - Site Cleanup Based on Actual Risk
 - Development of Numeric Requirements
 - Provides Clear Predictable Standards
- Establishes the Industrial Sites Cleanup Fund
 - An Aid to Redevelopment Interests
- Provides a Mechanism to Obtain a Release of Liability for Environmental Conditions on Real Estate

The Act 2 regulations were enacted in August 1997 and were updated in 2011. The regulations provide the regulatory framework under which the procurement of Act 2 liability protection can be obtained. The Act 2 Technical Guidance Manual was issued in December 1997 and updated in December 2001 to assist in the interpretation of the rules and regulations, and to establish PADEP policy regarding subjective issues. As a result of these documents, a formal process of submittals, notices, and procedures has been established. A summary of the primary elements of the Act 2 process are as follows:

1. Public Notice

- Publish a Notice of Intent to Remediate in local newspaper.
- Notify local government of Intent to Remediate.

2. Remedial Investigation

- Includes an environmental assessment that may be detailed in a Work Plan submitted to and approved by the PADEP.
- Intended to determine the nature and extent of contamination.
- Used to determine which one of three available Act 2 standards will be achieved:
 - Site-Specific Standard
 - Statewide Health Standard
 - Background Standard
- Results in a report that documents the findings of the Remedial Investigation.

3. Cleanup Activities/Risk Assessment (as applicable)

 As warranted, cleanup and/or risk assessment activities may be warranted to attain the selected Act 2 standard. Cleanup and/or risk assessment activities are then documented in a report submitted to the PADEP.



4. Final Report

- Report intended to document the attainment of an Act 2 Standard.
- Attainment of an Act 2 Standard provides the cleanup liability protection. A letter from the PADEP is issued documenting its concurrence with the attainment demonstration in the Final Report.

Act 2 is a voluntary program which is utilized by property owners and other stakeholders in cases where they seek to obtain the liability protection available under the Act 2 program. The sampling and analysis program identified within this SAP has been prepared based upon general Act 2 program requirements, to facilitate possible continuation of the Site in the Act 2 program at a future date.

A.2.3 Proposed Action Levels

The analytical results of the sampling and analysis program for soil will be compared against the tabulated Pennsylvania Act 2 MSCs for preliminary screening purposes. The Act 2 MSC tables consider multiple site characteristics and end-use scenarios (e.g., used aquifer versus non-used aquifer, residential site versus non-residential site, etc.), and the analytical data will be compared to the most applicable Act 2 screening values, to the extent possible, based on the available Site information. In instances where specific Site information is limited, the analytical data will be compared against multiple screening values which may be applicable, such as the U.S. EPA Regional Screening Levels.

A.2.4 Data Quality Objectives Process

This section provides a brief summary of the data quality objectives (DQO) process, which incorporates the following information:

- State the problem;
- Identify the decision(s) to be made;
- Identify what information is needed to make informed, defensible decisions;
- Define the boundaries of the investigation;
- Develop a decision rule; and
- Specify the limits on decision error.

The DQOs are summarized in Table 1.

A.3 Project Timeline

The scope of work activities identified within this SAP will require approximately 4 weeks to complete per the following anticipated project timeline:



ACTIVITY	START DATE	APPROXIMATE COMPLETION DATE
1) Planning/Preparatory Activities	Week 1 (Upon Approval)	Week 1
2) Field Work	Week 1	Week 1
(Excavate trenches and collect soil samples)		
3) Analytical Data Analysis and	Week 3	Week 3
Data Validation, if needed		
4) Report	Week 4	Week 4

A.4 Measurement Quality Objectives

The approved QAPP establishes the program-wide Measurement Quality Objectives (Section A.3 of the QAPP). See Table 3, Measurement Quality Indicators.

B. MEASUREMENT AND DATA ACQUISITION

B.1 Conceptual Site Model

The potential for adverse risks to arise from contact with constituents in an environmental medium is based on the following four factors: 1) chemicals must be present at hazardous levels, 2) an environmental medium must be present to receive or transport the chemicals, 3) receptors must be present, and 4) exposure pathways must exist between the source of the chemicals and receptors. In the absence of any one of the four components, risks do not exist. The presence of all four elements indicates a potential for risks to human health, but does not necessarily indicate an unacceptable risk.

Development of a conceptual site model is a critical step in the Phase II ESA process to identify the potential sources of constituents, the release mechanisms into environmental media, and potential exposure pathways and receptors.

Target Analytes

The Site and adjoining properties were historically utilized as portions of a larger industrial facility, the Industrial Center of McKeesport. The history of the Industrial Center of McKeesport dates back to 1870 and included the following:

- Fulton-Bolman Company
- Flagler Company
- National Tube Works
- National Tube Company



The National Tube Works/Company produced steel tube and pipe of varying sizes and characteristics. The Site specifically consisted of the former Laddle Repair Building and a portion of the Blowing Room structure. In 1987, the National Tube Works shut down. Since circa 1987, the Site has been vacant.

According to the 2000 RI-RA-CP Report, constituents detected above the applicable MSCs in soil at the Industrial Center of McKeesport included cadmium, iron, lead, mercury, vanadium, benzo(b)fluoranthene, benzo(k)fluoranthene, and methylene chloride. Constituents detected above the applicable MSCs in groundwater were lead, ammonia, naphthalene, and PCE. Based on the findings of the RI-RA-CP Report, the additional Phase II assessment SAP activities will include the collection of surface and subsurface soil samples at various locations to augment the existing soil quality data for the Site. These soil samples will be analyzed for organic constituents only; in order to verify that these constituents are located on the Site. It is assumed from past data that metals are present at the Site, since metal contamination was dispersed throughout the Industrial Center of McKeesport property. Organic constituent detections were more isolated.

Pathways of Interest

Information regarding Site hydrogeology indicates that there is a relatively thick unsaturated zone present across the Site, with groundwater levels occurring at depths of 25 to 30 feet. The upper unit is predominantly composed of slag fill, with minor occurrences of other fill materials such as brick, sand, and soil.

There is no evidence suggesting the disposal of chemical waste materials during the placement of this fill unit. Any constituents present in soils at the Site would, therefore, be expected to have originated from facility operations, and entered Site soils at or near the ground surface. For these constituents to enter groundwater, they would have to migrate through the remaining thickness of unsaturated fill via a leaching mechanism to a depth of 25 to 30 feet below grade. Any subsequent constituent migration in the groundwater would be to the north, with an ultimate discharge to the Monongahela River.

In a typical setting, multiple migration pathways exist that create the potential for contact between chemical constituents and receptors. These pathways include direct ingestion, inhalation, or dermal contact with soil and/or groundwater. Constituents may also migrate through the soil to groundwater, and groundwater may migrate to surface water. Finally, vapors from contaminants present in soil and/or groundwater may migrate upwards to the surface, creating an indoor air exposure pathway. Act 2 allows a remediator to eliminate potential migration exposure pathways where it can be demonstrated that the pathway either does not exist or results in acceptable exposure levels based upon current guidance or regulations.

Groundwater is not currently in use on the Site or adjoining properties. These properties are provided water from the municipal water supplier. Future use of groundwater will be restricted via an environmental covenant. Therefore, further groundwater characterization is not included in this SAP.



B.2 Sampling Design

A comprehensive sampling design program has been developed to verify if organic constituents are present in the Site soil. The following will be incorporated into the sample design:

- Soil samples will be collected from with the 0- to 4-foot depth interval from four excavated trenches.
- One trench, each, will be located in the four cardinal quadrangles of the Site (North, South, East, and West). These trenches will overlap slightly to ensure that the entire Site is covered.
- Two composite soil samples will be collected from each of the four trench areas for a total of eight samples, with the exception of any suspect material.
- Suspect material (material with visible and/or odorous indications of soil quality impacts) will be sampled separately.
- All of the soil samples will be analyzed for Target Compound List (TCL) PCBs and TCL semi-volatile organic compounds (SVOCs).
- All of the soil samples will be field screened with a photoionization detector (PID). Any soil samples that are above background levels on the PID will also be analyzed for TCL volatile organic compounds (VOCs).
- TCL PCBs will be analyzed via laboratory Method 8082A. TCL SVOCs will be analyzed via Method 8270D. TCL VOCs will be analyzed via Method 8260C.

Data collected will be compared to Pennsylvania's Act 2 MSCs for non-residential soil direct contact and soil to groundwater. Figure 2 identifies the Site boundaries and the sampling locations on an aerial photograph. The soil samples proposed in the SAP will also provide general on-Site soil quality information.

B.3 Sampling Method

The program-wide sampling methodologies and SOPs for the Turtle Creek Valley Council of Governments' (TCVCOG's) Cooperative Agreement have been provided within the QAPP and will be followed during the implementation of this SAP. These SOPs are included in Appendix A of the SAP. A summary of the sampling techniques for the various environmental media to be investigated at the Site follows. See Table 2 for sampling and analytical methods requirements.

B.3.1 Trench Sampling Method

Trenches will be excavated to 4 feet below ground surface, equipment refusal/bedrock, or groundwater, whichever occurs first. The trenches will be excavated using a back-hoe vehicle. Two composite soil samples will be collected from ground surface to the bottom of each trench.

All samples will be examined in the field, and field logs noting soil and lithologic descriptions, environmental quality observations, and other pertinent information will be maintained. Based on field observations (i.e., visible and/or odorous indications of soil quality impacts), selected aliquots of soil



samples will be field-screened. The soil samples will be field screened with a PID equipped with a 10.6 electron volt (eV) lamp. The soil samples will be screened on a minimum of 2-foot intervals. The soil samples will be placed into air-tight zipped baggies, following excavation. Screening of these samples will occur immediately after opening each baggie. The results of the field screening will be recorded as a parts-per-million concentration in the field logbook.

These results will be used to determine if the soil samples will be submitted for TCL VOC analysis, in addition to TCL PCB and TCL SVOC analyses. Additional soil samples may be collected based on field observations of the trenches. Samples selected for laboratory analysis will be transferred to sample containers. Trenches will be backfilled upon completion of the sampling.

In accordance with EPA Method 5035, sample containers utilized for VOC analysis will be prepared in the laboratory. Sample container preparation will consist of adding a clean magnetic stirring bar and appropriate preservative (either sodium bisulfate or methanol) to a 40-ml vial, attaching a pre-marked label to the vial, and weighing it to the nearest 0.1 gram. Samples will be collected in the field by inserting a plastic syringe (with the end removed) into the soil being sampled. The sample will then be transferred from the syringe to the 40-ml vial, placed in a packing container, and preserved by packing the sample vial in ice.

The soil samples will be submitted to a certified laboratory for analysis. Filled sample containers will be placed on ice in insulated coolers pending completion of each day's sampling activities. Samples will be packaged for delivery to the laboratory at the completion of each working day, ensuring that the samples will remain cool (approximately 4° C) until logged in by the laboratory. The shipping containers will be accompanied by a completed lab-supplied chain-of-custody form.

B.3.2 Investigation-Derived Waste Sampling Method

During the course of the field investigation, disposable/single-use equipment, personal protective equipment, and investigation-derived waste (IDW) samples (e.g., soil boring cuttings) can be generated. IDW will be segregated and containerized, as needed, for proper disposal.

B.4 Analytical Methods Requirements

The analytical methods to be used during the implementation of this Site-specific SAP are identified in Section B.2, Sampling Design. The QAPP also addresses the analytical parameters of TCVCOG's overall Cooperative Agreement with the U.S. EPA.

C. ASSESSMENT AND OVERSIGHT

C.1 Performance and Systems Audits

During field activities, the Quality Control Manager of the project will determine whether the field activities are following protocols delineated in the QAPP and SAP. If the protocols are not being followed, the



procedures described in Section C.1 of the QAPP will be implemented to address how these issues will be handled and resolved.

Only laboratories that have defined QA protocol will be selected.

C.2 Reports to Managements

Status reports will not be required as the Site activities will be complete within one month's time. If the project is delayed for three months or more, quarterly status reports will be prepared.

D. DATA VALIDATION AND USABILITY

The QAPP (Section D) provides the data validation and usability protocols and how the overall DQOs for this project will be met by verifying the methods and results to collect, develop, and report the data.

Any issues associated with data usability will be resolved through the consultant's experience with the protocols and limitations associated with Pennsylvania's Act 2 program. Any limitations on the use of the data will be conveyed to the decision makers through periodic program updates, as well as within the Additional Phase II Assessment Activities report which will document the implementation of this SAP.

E. REFERENCES

ASTM International, 2011. "Standard Practice for Environmental Site Assessments: Phase II Environmental Site Assessment Process." Designation: E1903-11. July 2011.

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KU Resources, Inc., 2013. "Turtle Creek Valley Council of Governments, Programmatic Quality Assurance Project Plan, Phase I and Phase II Environmental Site Assessments, Multiple Properties, Allegheny County, Pennsylvania." May 2013.



TABLES



Table 1 Data Quality Objectives

The Site is part of the larget language of the state and larger Industrial Center of McKeesport. This soil concentrations for the utilized for the utilized for the warmanufacturing of steel owner plans are to covered property for manufacturing of steel owner plans are to hard manufacturing of steel contamination is metal contamination is more isolated. The primary type of Trenches will be excavated within the excavated within the boundaries of the Site. The current statement is laboratory analyzes of surface and approximately 4 weeks subsurface soil samples from newly excavated trenches. RI-RA-CP Report, Based on the results of analyzed for TCL-ords pending is more isolated. The primary type of excavated within the excavated within the boundaries of the Site. The current statement is laboratory analyzed on the results of analyzed for TCL-ords pending is more isolated. The primary type of excavated within the excavated within the boundaries of the Site. The current statement is laboratory analyzed for TCL-ords pending in metal contamination is more isolated. The proceed. The primary type of excavated within the excavated within the boundaries of the Site. The current is excavated within the site or manufacturing or the Site. The current statement is laboratory analyzed for TCL-ords pending in metal contamination is more isolated. The proceed. The procedure of the concentration of the Site. True or provided within the soil or excavated trenches. The procedure of the Site. The current in the Site. The Site. True or provided within the soil or excavated trenches. The procedure of the Site. True or excavated within the statement is laborated within the soil or excavated within the statement is laborated. The procedure of the Site of the Site of the Site of the Sit	identify the Inputs to Define the Study the Decision(s) Boundaries		Develop Decision Rules	Tolerable Limits on Errors
proposed to determine information that needs soil concentrations for organic constituents at the Site. The current owner plans are to owner plans are to redevelop property for non-residential use. Based on the results of the investigation, it will be determine if be determine if redevelopment can proceed. Information that needs in order to resolve the decision strategies amples from newly excavated trenches. Soil samples will be analyzed for TCL-remediation strategies are needed or redevelopment can proceed. PCL-VOCs pending field screening with a PID.			Provide the chemical	Data validation will be
soil concentrations for organic constituents at the Site. The current owner plans are to redevelop property for non-residential use. Based on the results of the investigation, it will be determine if remediation strategies are needed or redevelopment can proceed. TCL-VOCs pending progential use. Soil samples from newly excavated trenches. Soil samples will be analyzed for TCL-redevelopment can field screening with a PID.	information that needs	,, <u></u>	concentrations of	performed in
organic constituents at to resolve the decision the Site. The current statement is laboratory owner plans are to redevelop property for non-residential use. Based on the results of the investigation, it will be determine if remediation strategies are needed or redevelopment can proceed. TCL-VOCs pending proceed. TCL-VOCs pending field screening with a PID.	to be obtained in order		organics in the soil on	accordance with the
the Site. The current statement is laboratory owner plans are to redevelop property for non-residential use. Based on the results of the investigation, it will be determine if remediation strategies are needed or redevelopment can proceed. TCL-VOCs pending proceed. Publication strategies and strategies and samples from newly excavated trenches. Soil samples will be analyzed for TCL-remediation strategies and limited analysis for redevelopment can field screening with a PID.	to resolve the decision		the Site. The data	programmatic QAPP, if
owner plans are to redevelop property for non-residential use. Based on the results of the investigation, it will be determine if remediation strategies are needed or redevelopment can proceed. TCL-VOCs pending proceed. Publication surface and surface and subsequences amples from newly excavated trenches. Soil samples will be analyzed for TCL-remediation strategies and limited analysis for redevelopment can field screening with a PID.	statement is laboratory		collected will be	warranted.
redevelop property for non-residential use. Based on the results of the investigation, it will be determine if analyzed for TCL-redevelopment can proceed. TCL-VOCs pending proceed. Subsurface soil samples from newly excavated trenches. Soil samples will be analyzed for TCL-results from the proceed or and limited analysis for TCL-vocs pending field screening with a PID.	analyses of surface and		compared to the most	
non-residential use. Based on the results of the investigation, it will be determine if remediation strategies are needed or redevelopment can proceed.	subsurface soil	,	applicable Act 2	
Based on the results of the investigation, it will be determine if remediation strategies are needed or redevelopment can proceed.		SCI	screening values or	
the investigation, it will be determine if remediation strategies are needed or redevelopment can proceed.		othe	other screening values	
be determine if remediation strategies are needed or redevelopment can proceed.			which may be	
remediation strategies are needed or redevelopment can proceed.		appli	applicable, to the extent	
are needed or redevelopment can proceed.		ssod	possible, based on the	
	and limited analysis for		available Site	
			information. If	
	field screening with a	SCF	screening values are	
	PID.	exc	exceeded, then it will	
		pe a	be ascertained if there	
		. <u>S</u>	is a threat to pubic	u vega a emma
			health or the	r (i a a a a a a
		- eu	environment and if	
		rem	remediation strategies	
		neec	need to be formulated.	and the second second

Sampling and Analytical Methods Requirements Table 2

Matrix	Parameter	Number of Samples ⁽¹⁾	Number of Sampling Samples (1) Procedure (2)	Sample Preparation Extraction Method Number	Analytical Method
Soil	Soil TCL-Polychlorinated Biphenyl (PCBs)	8	SOP SA-5.3	3541	8082A
Soil	Soil TCL-Semi-Volatile Organic Compouds (SVOCs)	8	SOP SA-5.3	3541	8270D
Soil	Soil Target Compound List (TCL)-Volatile Organic Compounds (VOCs)	(#)	SOP SA-5.3	5035	8260C

Soil sample number does not include QA/QC samples. Soil sample number is derived from collecting two composite samples from each trench. VOC analysis is dependent on field screening with PID. See report for further details.
 Standard Operating Procedures are from the Turtle Creek Valley Council of Governments, Programmatic Quality Assurance Project Plan, Phase I and Phase II Environmental Site Assessments, Multiple Properties, Allegheny County, Pennsylvania (KU Resources, Inc., May 2013) previously approved by the U.S. Environmental Protection Agency.

Table 3
Measurement Quality Indicators

		Action Limi	it ⁽¹⁾ (ma/ka)			
		ACTION LIM	Subsurface			
	Marie de M	Surface Soil	Soil			
Analyte	Matrix	(0-2 ft)	(2-15 ft)	Precision	Accuracy	Completeness
VOCs - Methods 8260C & 82						
Acetone	Soil	9200	9200	30	40-100	Equal to or greater than 95%
Benzene	Soil	0.5	0.5	30	70-130	Equal to or greater than 95%
Bromodichloromethane	Soil	9	9	30	40-150	Equal to or greater than 95%
Bromoform	Soil	8	8	30	40-170	Equal to or greater than 95%
Bromomethane	Soil	1	1	30	25-180	Equal to or greater than 95%
2-Butanone (MEK)	Soil	400	400	30	60-140	Equal to or greater than 95%
Carbon disulfide	Soil	620	620	30	70-125	Equal to or greater than 95%
Carbon tetrachloride	Soil	0.5	0.5	30	70-130	Equal to or greater than 95%
Chlorobenzene	Soil	10	10	30	40-160	Equal to or greater than 95%
Chloroethane	Soil	90	90	30	25-180	Equal to or greater than 95%
Chloroform	Soil	8	8	30	50-150	Equal to or greater than 95%
Chloromethane	Soil	3	3	30	25-180	Equal to or greater than 95%
Dibromochloromethane	Soil	8	8	30	40-150	Equal to or greater than 95%
1,2-Dichlorobenzene	Soil	60	60	30	20-175	Equal to or greater than 95%
1,3 Dichlorobenzene	Soil	60	60	30	60-155	Equal to or greater than 95%
1,4 Dichlorobenzene	Soil	10	10	30	20-175	Equal to or greater than 95%
1,1-Dichloroethane	Soil	16	16	30	60-150	Equal to or greater than 95%
1,2-Dichloroethane	Soil	0.5	0.5	30	50-150	Equal to or greater than 95%
1,2-Dichloroethene	Soil	7	7	30	50-155	Equal to or greater than 95%
1,1-Dichloroethene	Soil	0.7	0.7	30	25-180	Equal to or greater than 95%
1,2-Dichloropropane	Soil	0.5	0.5	30	25-180	Equal to or greater than 95%
cis-1,3-Dichloropropene	Soil	2.6	2.6	30	20-180	Equal to or greater than 95%
trans-1,3-Dichloropropene	Soil	2.6	2.6	30	20-180	Equal to or greater than 95%
Ethylbenzene	Soil	70	70	30	40-160	Equal to or greater than 95%
2-Hexanone	Soil	4.4	4.4	30	60-140	Equal to or greater than 95%
Methylene Chloride	Soil	0.5	0.5	30	25-180	Equal to or greater than 95%
4-Methyl-2-pentanone (MIBK)	Soil	820	820	30	60-140	Equal to or greater than 95%
Methyl-tert-butyl ether	Soil	2	2	30	70-130	Equal to or greater than 95%
Styrene	Soil	24	24	30	70-140	Equal to or greater than 95%
1,1,2,2-Tetrachloroethane	Soil	0.43	0.43	30	50-160	Equal to or greater than 95%
Tetrachloroethene	Soil	0.5	0.5	30	60-150	Equal to or greater than 95%
Toluene	Soil	100	100	30	50-140	Equal to or greater than 95%
1,1,1-Trochloroethane	Soil	20	20	30	50-160	Equal to or greater than 95%
1,1,2-Trochloroethane	Soil	0.5	0.5	30	50-150	Equal to or greater than 95%
Trichloroethene	Soil	0.5	0.5	30	70-150	Equal to or greater than 95%
Vinyl chloride	Soil	0.2	0.2	30	20-180	Equal to or greater than 95%
Xylenes, Total	Soil	1000	1000	30	70-140	Equal to or greater than 95%

Table 3
Measurement Quality Indicators

		Action Limi	t ⁽¹⁾ (mg/kg)			
			Subsurface	-		
Augustusta	B. a. a. a. in a	Surface Soil	Soil	Duccialan	A	Camanlatanasa
Analyte SVOCa Mathed 8270D	Matrix	(0-2 ft)	(2-15 ft)	Precision	Accuracy	Completeness
SVOCs – Method 8270D	Soil	4700	4700	30	60-110	
Acenaphthene				30	60-110	Equal to or greater than 95%
Acenaphthylene	Soil	6900	6900			Equal to or greater than 95%
Anthracene	Soil	350	350	30	60-110	Equal to or greater than 95%
Benzo(a)anthracene	Soil	110	320	30	60-110	Equal to or greater than 95%
Benzo(a)pyrene	Soil	11	46	30	60-110	Equal to or greater than 95%
Benzo(b)fluoranthene	Soil	110	170	30	60-110	Equal to or greater than 95%
Benzo(g,h,i)perylene	Soil	180	180	30	40-125	Equal to or greater than 95%
Benzo(k)fluoranthene	Soil	610	610	30	60-125	Equal to or greater than 95%
Benzyl alcohol	Soil	5100	5100	30	25-150	Equal to or greater than 95%
4-Bromophenyphenyl ether	Soil			30	50-140	Equal to or greater than 95%
Butylbenzylphthalate	Soil	10000	10000	30	40-130	Equal to or greater than 95%
4-Chloro-3-methylphenol	Soil			30	50-115	Equal to or greater than 95%
4-Chloroaniline	Soil	1.6	1.6	30	30-170	Equal to or greater than 95%
bis(2-Chloroethoxy) methane	Soil	31	31	30	30-180	Equal to or greater than 95%
bis(2-Chloroethyl) ether	Soil	0.076	0.076	30	25-160	Equal to or greater than 95%
Bis(2-Chloroisopropyl) ether	Soil	30	30	30	40-170	Equal to or greater than 95%
2-Chloronaphthalene	Soil	18000	18000	30	30-170	Equal to or greater than 95%
2-Chlorophenol	Soil	4.4	4.4	30	50-110	Equal to or greater than 95%
4-Chlorophenylphenyl ether	Soil			30	50-150	Equal to or greater than 95%
Chrysene	Soil	230	230	30	60-110	Equal to or greater than 95%
Dibenzo(a,h)anthracene	Soil	11	160	30	50-125	Equal to or greater than 95%
Dibenzofuran	Soil	260	260	30	50-130	Equal to or greater than 95%
1,2 Dichlorobenzene	Soil	60	60	30	20-175	Equal to or greater than 95%
1,3-Dichlorobenzene	Soil	61	61	30	60-155	Equal to or greater than 95%
1,4-Dichlorobenzene	Soil	10	10	30	20-175	Equal to or greater than 95%
3,3'-Dichlorobenzidine	Soil	32	32	30	30-170	Equal to or greater than 95%
2,4-Dichlorophenol	Soil	2	2	30	50-110	Equal to or greater than 95%
Diethylphthalate	Soil	8200	8200	30	25-120	Equal to or greater than 95%
2,4-Dimethylphenol	Soil	200	200	30	40-110	
Dimethylphthalate	Soil			30	25-120	Equal to or greater than 95% Equal to or greater than 95%
Di-n-butylphthalate	Soil			30	60-160	Equal to or greater than 95%
4,6-Dinitro-2-methylphenol	Soil			30	50-135	Equal to or greater than 95%
2,4-Dinitrophenol	Soil	20	20	30	30-130	
2,4-Dinitrotoluene	Soil	0.84	0.84	30	40-140	Equal to or greater than 95%
2,6-Dinitrotoluene	Soil	10	10	30	50-160	Equal to or greater than 95%
Di-ni-octylphthalate	Soil	300	300	30	25-150	Equal to or greater than 95%
	Soil	130	130	30	75-160	Equal to or greater than 95%
bis(2-Ethylhexyl)phthalate	Soil	3200	3200	30	60-110	Equal to or greater than 95%
Fluoranthene	Soil	3800	3800	30	60-110	Equal to or greater than 95%
Fluorene	Soil	39	39	30	30-170	Equal to or greater than 95%
Hexachloro-1,3-butadiene	Soil	0.96	0.96			Equal to or greater than 95%
Hexachlorobenzene	Soil	91	91	30	25-150	Equal to or greater than 95%
Hexachlorocyclopentadiene	Soil	0.56	0.56	30	30-170	Equal to or greater than 95%
Hexachloroethane				30	40-140	Equal to or greater than 95%
Indeno(1,2,3-cd)pyrene	Soil	110	110	30	50-120	Equal to or greater than 95%
Isophorone	Soil	10	10	30	20-190	Equal to or greater than 95%
2-Methynaphthalene	Soil	1600	1600	30	40-140	Equal to or greater than 95%

Table 3
Measurement Quality Indicators

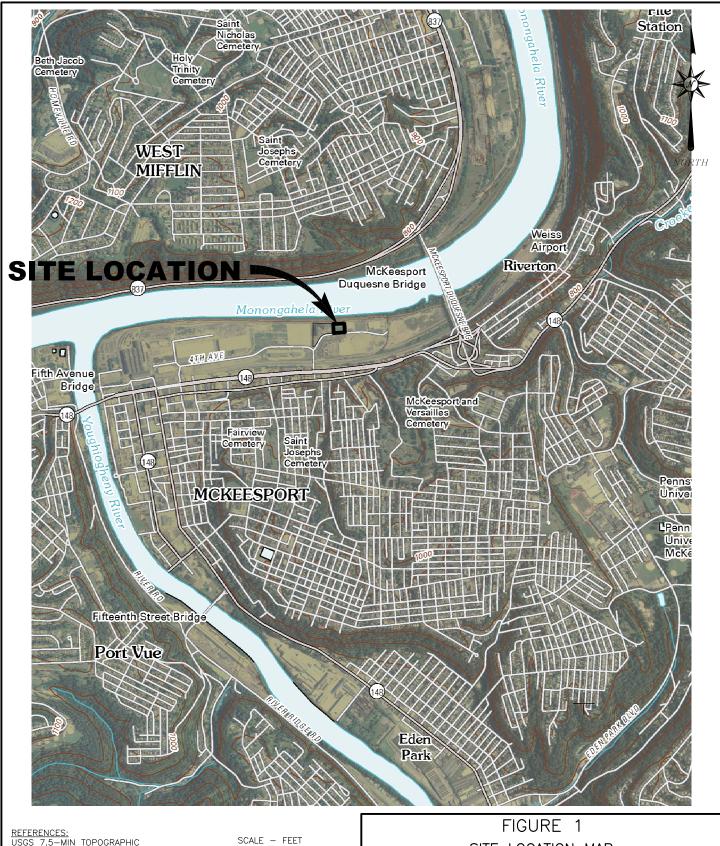
		Action Limi	t ⁽¹⁾ (mg/kg)			
Analyte	Matrix	Surface Soil (0-2 ft)	Subsurface Soil (2-15 ft)	Precision	Accuracy	Completeness
SVOCs - Method 8270D						
2-Methylphenol(o-cresol)	Soil	510	510	30	50-115	Equal to or greater than 95%
3,4-Methyphenol(m&p cresol)	Soil	51	51	30	30-125	Equal to or greater than 95%
Naphthalene	Soil	25	25	30	40-110	Equal to or greater than 95%
2-Nitroaniline	Soil	31	31	30	30-150	Equal to or greater than 95%
3-Nitroaniline	Soil	3.1	3.1	30	30-150	Equal to or greater than 95%
4-Nitroaniline	Soil	13	13	30	30-150	Equal to or greater than 95%
Nitrobenzene	Soil	20	20	30	30-150	Equal to or greater than 95%
2-Nitrophenol	Soil	82	82	30	50-110	Equal to or greater than 95%
4-Nitrophenol	Soil	6	6	30	50-130	Equal to or greater than 95%
N-Nitroso-di-n-propylamine	Soil	0.0001	0.0001	30	20-150	Equal to or greater than 95%
N-Nitrosodiphenylamine	Soil	0.0018	0.0018	30	40-150	Equal to or greater than 95%
Pentachlorophenol	Soil	5	5	30	50-120	Equal to or greater than 95%
Phenanthrene	Soil	10000	10000	30	60-110	Equal to or greater than 95%
Phenol	Soil	200	200	30	40-100	Equal to or greater than 95%
Pyrene	Soil	2200	2200	30	50-115	Equal to or greater than 95%
1,2,4-Trichlorobenzene	Soil	27	27	30	75-125	Equal to or greater than 95%
2,4,5-Trichlorophenol	Soil	6100	6100	30	60-115	Equal to or greater than 95%
2,4,6-Trichlorophenol	Soil	29	29	30	60-115	Equal to or greater than 95%
PCBs - Method 8082A						
Aroclor 1016	Soil	200	200	30	60-130	Equal to or greater than 95%
Aroclor 1221	Soil	0.63	0.63	NA	NA	Equal to or greater than 95%
Aroclor 1232	Soil	3.3	3.3	NA	NA	Equal to or greater than 95%
Aroclor 1242	Soil	16	16	NA	NA	Equal to or greater than 95%
Aroclor 1248	Soil	40	62	NA	NA	Equal to or greater than 95%
Aroclor 1254	Soil	40	260	NA	NA	Equal to or greater than 95%
Aroclor 1260	Soil	40	590	30	60-130	Equal to or greater than 95%

Note:

(1)Pennsylvania Act 2 Non-residential, Used Aquifer, Medium-Specific Concentrations (MSCs). The MSCs listed for soil represents the concentration of direct contact or soil to groundwater, whichever is the lowest, for the each of the analytes.

FIGURES









100001/50	MBH 00 (05	/0044	
REVISION	DATE		DESCRIPTION

 APPROVED
 MRU
 09/25/2014

 CHECKED
 SBU
 09/25/2014

 DRAWN
 RAM
 09/25/2014

 CAD FILE
 NO.
 14341**

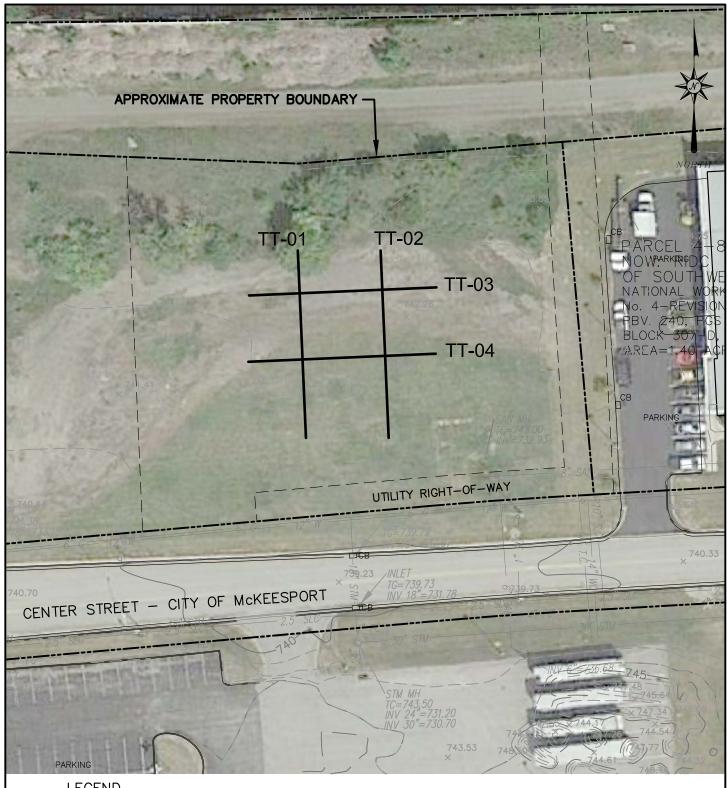
 PROJECT
 NO. TCVC
 14341
 CSP



SITE LOCATION MAP
INDUSTRIAL CENTER OF McKEESPORT
EAST PORTION OF PARCEL 307-D-001
CITY OF McKEESPORT
ALLEGHENY COUNTY, PENNSYLVANIA

PREPARED FOR

TURTLE CREEK VALLEY
COUNCIL OF GOVERNMENTS
MONROEVILLE, PENNSYLVANIA



LEGEND

TT-01 ---- PROPOSED TEST TRENCH

REFERENCES: SURVEY MAPPING PROVIDED BY SENATE ENGINEERING DRAWING NUMBER D5189, DATED 10/28/2009. IMAGE BY GOOGLE EARTH



APPROVED	MRU	09/25/2014	
CHECKED	SBU	09/25/2014	1
DRAWN	RAM	09/25/2014	
CAD FILE NO		14341A002	- 1
PROJECT NO.	TCV	'C 14341 CSP	

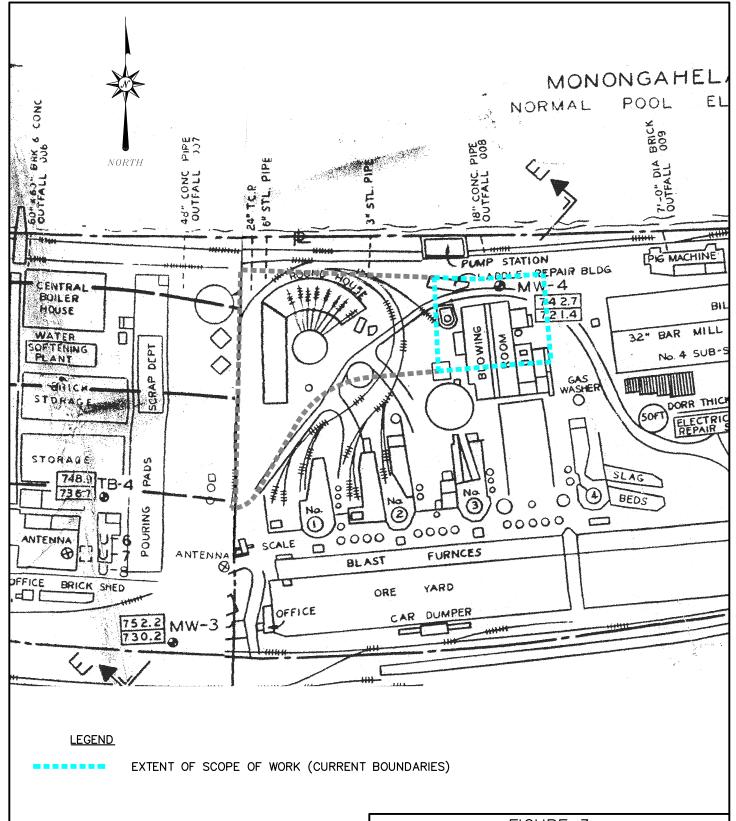


FIGURE 2

TEST TRENCH LOCATIONS
INDUSTRIAL CENTER OF McKEESPORT
EAST PORTION OF PARCEL 307-D-001
CITY OF McKEESPORT
ALLEGHENY COUNTY, PENNSYLVANIA

PREPARED FOR

TURTLE CREEK VALLEY
COUNCIL OF GOVERNMENTS
MONROEVILLE, PENNSYLVANIA



REFERENCE:
PROJECT NO. 2U024.00, DRAWING 6 OF
10, FIGURE 2-2, MILL OPERATIONS IN
THE 1980s, BY DUNCAN, LAGNESE AND
ASSOCIATES, INCORPORATED,
PITTSBURGH, PA, DATED DEC. 31, 1987,
REVISED 3/16/88.



APPROVED	MRU 09/25/2014
CHECKED	SBU 09/25/2014
DRAWN	RAM 09/25/2014
CAD FILE NO	
PROJECT NO.	TCVC 14341 CSP



FIGURE 3

HISTORIC OPERATIONS
INDUSTRIAL CENTER OF McKEESPORT
EAST PORTION OF PARCEL 307-D-001
CITY OF McKEESPORT
ALLEGHENY COUNTY, PENNSYLVANIA

TURTLE CREEK VALLEY
COUNCIL OF GOVERNMENTS
MONROEVILLE, PENNSYLVANIA

APPENDIX



Appendix A Standard Operating Procedures [on CD]





TETRA TECH NUS, INC.

STANDARD OPERATING PROCEDURES

Number	Page
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Effective Date	Revision
06/99	1

Applicability

Tetra Tech NUS, Inc.

Prepared

Earth Sciences Department

Approved

D. Senovich

Subject

BOREHOLE AND SAMPLE LOGGING

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BOREHOLE AND SAMPLE LOGGING	Revision	Effective Date
	1	06/99

1.0 PURPOSE

The purpose of this document is to establish standard procedures and technical guidance on borehole and sample logging.

2.0 SCOPE

These procedures provide descriptions of the standard techniques for borehole and sample logging. These techniques shall be used for each boring logged to provide consistent descriptions of subsurface lithology. While experience is the only method to develop confidence and accuracy in the description of soil and rock, the field geologist/engineer can do a good job of classification by careful, thoughtful observation and by being consistent throughout the classification procedure.

3.0 GLOSSARY

None.

4.0 RESPONSIBILITIES

<u>Site Geologist</u>. Responsible for supervising all boring activities and assuring that each borehole is completely logged. If more than one rig is being used on site, the Site Geologist must make sure that each field geologist is properly trained in logging procedures. A brief review or training session may be necessary prior to the start up of the field program and/or upon completion of the first boring.

5.0 PROCEDURES

The classification of soil and rocks is one of the most important jobs of the field geologist/engineer. To maintain a consistent flow of information, it is imperative that the field geologist/engineer understand and accurately use the field classification system described in this SOP. This identification is based on visual examination and manual tests.

5.1 <u>Materials Needed</u>

When logging soil and rock samples, the geologist or engineer may be equipped with the following:

- Rock hammer
- Knife
- Camera
- Dilute hydrochloric acid (HCI)
- Ruler (marked in tenths and hundredths of feet)
- Hand Lens

5.2 Classification of Soils

All data shall be written directly on the boring log (Figure 1) or in a field notebook if more space is needed. Details on filling out the boring log are discussed in Section 5.5.

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5.2.1 USCS Classification

Soils are to be classified according to the Unified Soil Classification System (USCS). This method of classification is detailed in Figure 1 (Continued).

This method of classification identifies soil types on the basis of grain size and cohesiveness.

Fine-grained soils, or fines, are smaller than the No. 200 sieve and are of two types: silt (M) and clay (C). Some classification systems define size ranges for these soil particles, but for field classification purposes, they are identified by their respective behaviors. Organic material (O) is a common component of soil but has no size range; it is recognized by its composition. The careful study of the USCS will aid in developing the competence and consistency necessary for the classification of soils.

Coarse-grained soils shall be divided into rock fragments, sand, or gravel. The terms sand and gravel not only refer to the size of the soil particles but also to their depositional history. To insure accuracy in description, the term rock fragments shall be used to indicate angular granular materials resulting from the breakup of rock. The sharp edges typically observed indicate little or no transport from their source area, and therefore the term provides additional information in reconstructing the depositional environment of the soils encountered. When the term "rock fragments" is used it shall be followed by a size designation such as " $(1/4 \text{ inch}\Phi-1/2 \text{ inch}\Phi)$ " or "coarse-sand size" either immediately after the entry or in the remarks column. The USCS classification would not be affected by this variation in terms.

5.2.2 Color

Soil colors shall be described utilizing a single color descriptor preceded, when necessary, by a modifier to denote variations in shade or color mixtures. A soil could therefore be referred to as "gray" or "light gray" or "blue-gray." Since color can be utilized in correlating units between sampling locations, it is important for color descriptions to be consistent from one boring to another.

Colors must be described while the sample is still moist. Soil samples shall be broken or split vertically to describe colors. Samplers tend to smear the sample surface creating color variations between the sample interior and exterior.

The term "mottled" shall be used to indicate soils irregularly marked with spots of different colors. Mottling in soils usually indicates poor aeration and lack of good drainage.

Soil Color Charts shall not be used unless specified by the project manager.

5.2.3 Relative Density and Consistency

To classify the relative density and/or consistency of a soil, the geologist is to first identify the soil type. Granular soils contain predominantly sands and gravels. They are noncohesive (particles do not adhere well when compressed). Finer-grained soils (silts and clays) are cohesive (particles will adhere together when compressed).

The density of noncohesive, granular soils is classified according to standard penetration resistances obtained from split-barrel sampling performed according to the methods detailed in Standard Operating Procedures GH-1.3 and SA-1.3. Those designations are:

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Designation	Standard Penetration Resistance (Blows per Foot)
Very loose	0 to 4
Loose	5 to 10
Medium dense	11 to 30
Dense	31 to 50
Very dense	Over 50

Standard penetration resistance is the number of blows required to drive a split-barrel sampler with a 2-inch outside diameter 12 inches into the material using a 140-pound hammer falling freely through 30 inches. The sampler is driven through an 18-inch sample interval, and the number of blows is recorded for each 6-inch increment. The density designation of granular soils is obtained by adding the number of blows required to penetrate the last 12 inches of each sample interval. It is important to note that if gravel or rock fragments are broken by the sampler or if rock fragments are lodged in the tip, the resulting blow count will be erroneously high, reflecting a higher density than actually exists. This shall be noted on the log and referenced to the sample number. Granular soils are given the USCS classifications GW, GP, GM, SW, SP, SM, GC, or SC (see Figure 1).

The consistency of cohesive soils is determined by performing field tests and identifying the consistency as shown in Figure 2.

Cohesive soils are given the USCS classifications ML, MH, CL, CH, OL, or OH (see Figure 1).

The consistency of cohesive soils is determined either by blow counts, a pocket penetrometer (values listed in the table as Unconfined Compressive Strength), or by hand by determining the resistance to penetration by the thumb. The pocket penetrometer and thumb determination methods are conducted on a selected sample of the soil, preferably the lowest 0.5 foot of the sample in the split-barrel sampler. The sample shall be broken in half and the thumb or penetrometer pushed into the end of the sample to determine the consistency. Do not determine consistency by attempting to penetrate a rock fragment. If the sample is decomposed rock, it is classified as a soft decomposed rock rather than a hard soil. Consistency shall not be determined solely by blow counts. One of the other methods shall be used in conjunction with it. The designations used to describe the consistency of cohesive soils are shown in Figure 2.

5.2.4 Weight Percentages

In nature, soils are comprised of particles of varying size and shape, and are combinations of the various grain types. The following terms are useful in the description of soil:

Terms of Identifying Proportion of the Component	Defining Range of Percentages by Weight
Trace	0 - 10 percent
Some	11 - 30 percent
Adjective form of the soil type (e.g., "sandy")	31 - 50 percent

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FIGURE 2 CONSISTENCY FOR COHESIVE SOILS

Consistency	Standard Penetration Resistance (Blows per Foot)	Unconfined Compressive Strength (Tons/Sq. Foot by pocket penetration)	Field Identification
Very soft	0 to 2	Less than 0.25	Easily penetrated several inches by fist
Soft	2 to 4	0.25 to 0.50	Easily penetrated several inches by thumb
Medium stiff	4 to 8	0.50 to 1.0	Can be penetrated several inches by thumb with moderate effort
Stiff	8 to 15	1.0 to 2.0	Readily indented by thumb but penetrated only with great effort
Very stiff	15 to 30	2.0 to 4.0	Readily indented by thumbnail
Hard	Over 30	More than 4.0	Indented with difficulty by thumbnail

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Examples:

- Silty fine sand: 50 to 69 percent fine sand, 31 to 50 percent silt.
- Medium to coarse sand, some silt: 70 to 80 percent medium to coarse sand, 11 to 30 percent silt.
- Fine sandy silt, trace clay: 50 to 68 percent silt, 31 to 49 percent fine sand, 1 to 10 percent clay.
- Clayey silt, some coarse sand: 70 to 89 percent clayey silt, 11 to 30 percent coarse sand.

5.2.5 Moisture

Moisture content is estimated in the field according to four categories: dry, moist, wet, and saturated. In dry soil, there appears to be little or no water. Saturated samples obviously have all the water they can hold. Moist and wet classifications are somewhat subjective and often are determined by the individual's judgment. A suggested parameter for this would be calling a soil wet if rolling it in the hand or on a porous surface liberates water, i.e., dirties or muddies the surface. Whatever method is adopted for describing moisture, it is important that the method used by an individual remains consistent throughout an entire drilling job.

Laboratory tests for water content shall be performed if the natural water content is important.

5.2.6 Stratification

Stratification can only be determined after the sample barrel is opened. The stratification or bedding thickness for soil and rock is depending on grain size and composition. The classification to be used for stratification description is shown in Figure 3.

5.2.7 Texture/Fabric/Bedding

The texture/fabric/bedding of the soil shall be described. Texture is described as the relative angularity of the particles: rounded, subrounded, subangular, and angular. Fabric shall be noted as to whether the particles are flat or bulky and whether there is a particular relation between particles (i.e., all the flat particles are parallel or there is some cementation). The bedding or structure shall also be noted (e.g., stratified, lensed, nonstratified, heterogeneous varved).

5.2.8 Summary of Soil Classification

In summary, soils shall be classified in a similar manner by each geologist/engineer at a project site. The hierarchy of classification is as follows:

- Density and/or consistency
- Color
- Plasticity (Optional)
- Soil types
- Moisture content
- Stratification
- Texture, fabric, bedding
- Other distinguishing features

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FIGURE 3
BEDDING THICKNESS CLASSIFICATION

Thickness (metric)	Thickness (Approximate English Equivalent)	Classification
> 1.0 meter	> 3.3'	Massive
30 cm - 1 meter	1.0' - 3.3'	Thick Bedded
10 cm - 30 cm	4" - 1.0'	Medium Bedded
3 cm - 10 cm	1" - 4"	Thin Bedded
1 cm - 3 cm	2/5" - 1"	Very Thin Bedded
3 mm - 1 cm	1/8" - 2/5"	Laminated
1 mm - 3 mm	1/32" - 1/8"	Thinly Laminated
< 1 mm	<1/32"	Micro Laminated

(Weir, 1973 and Ingram, 1954)

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5.3 Classification of Rocks

Rocks are grouped into three main divisions: sedimentary, igneous and metamorphic. Sedimentary rocks are by far the predominant type exposed at the earth's surface. The following basic names are applied to the types of rocks found in sedimentary sequences:

- Sandstone Made up predominantly of granular materials ranging between 1/16 to 2 mm in diameter.
- Siltstone Made up of granular materials less than 1/16 to 1/256 mm in diameter. Fractures irregularly. Medium thick to thick bedded.
- Claystone Very fine-grained rock made up of clay and silt-size materials. Fractures irregularly. Very smooth to touch. Generally has irregularly spaced pitting on surface of drilled cores.
- Shale A fissile very fine-grained rock. Fractures along bedding planes.
- Limestone Rock made up predominantly of calcite (CaCO₃). Effervesces strongly upon the application of dilute hydrochloric acid.
- Coal Rock consisting mainly of organic remains.
- Others Numerous other sedimentary rock types are present in lesser amounts in the stratigraphic record. The local abundance of any of these rock types is dependent upon the depositional history of the area. Conglomerate, halite, gypsum, dolomite, anhydrite, lignite, etc. are some of the rock types found in lesser amounts.

In classifying a sedimentary rock the following hierarchy shall be noted:

- Rock type
- Color
- Bedding thickness
- Hardness
- Fracturing
- Weathering
- Other characteristics

5.3.1 Rock Type

As described above, there are numerous types of sedimentary rocks. In most cases, a rock will be a combination of several grain types, therefore, a modifier such as a sandy siltstone, or a silty sandstone can be used. The modifier indicates that a significant portion of the rock type is composed of the modifier. Other modifiers can include carbonaceous, calcareous, siliceous, etc.

Grain size is the basis for the classification of clastic sedimentary rocks. Figure 4 is the Udden-Wentworth classification that will be assigned to sedimentary rocks. The individual boundaries are slightly different than the USCS subdivision for soil classification. For field determination of grain sizes, a scale can be used for the coarse grained rocks. For example, the division between siltstone and claystone may not be measurable in the field. The boundary shall be determined by use of a hand lens. If the grains cannot be seen with the naked eye but are distinguishable with a hand lens, the rock is a siltstone. If the grains are not distinguishable with a hand lens, the rock is a claystone.

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FIGURE 4

GRAIN SIZE CLASSIFICATION FOR ROCKS

Particle Name	Grain Size Diameter	
Cobbles	> 64 mm	
Pebbles	4 - 64 mm	
Granules	2 - 4 mm	
Very Coarse Sand	1 - 2 mm	
Coarse Sand	0.5 - 1 mm	
Medium Sand	0.25 - 0.5 mm	
ine Sand 0.125 - 0.25 mm		
Very Fine Sand	0.0625 - 0.125 mm	
Silt	0.0039 - 0.0625 mm	

After Wentworth, 1922

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5.3.2 Color

The color of a rock can be determined in a similar manner as for soil samples. Rock core samples shall be classified while wet, when possible, and air cored samples shall be scraped clean of cuttings prior to color classifications.

Rock color charts shall not be used unless specified by the Project Manager.

5.3.3 Bedding Thickness

The bedding thickness designations applied to soil classification (see Figure 3) will also be used for rock classification.

5.3.4 Hardness

The hardness of a rock is a function of the compaction, cementation, and mineralogical composition of the rock. A relative scale for sedimentary rock hardness is as follows:

- Soft Weathered, considerable erosion of core, easily gouged by screwdriver, scratched by fingernail.
 Soft rock crushes or deforms under pressure of a pressed hammer. This term is always used for the hardness of the saprolite (decomposed rock which occupies the zone between the lowest soil horizon and firm bedrock).
- Medium soft Slight erosion of core, slightly gouged by screwdriver, or breaks with crumbly edges from single hammer blow.
- Medium hard No core erosion, easily scratched by screwdriver, or breaks with sharp edges from single hammer blow.
- Hard Requires several hammer blows to break and has sharp conchoidal breaks. Cannot be scratched with screwdriver.

Note the difference in usage here of the works "scratch" and "gouge." A scratch shall be considered a slight depression in the rock (do not mistake the scraping off of rock flour from drilling with a scratch in the rock itself), while a gouge is much deeper.

5.3.5 Fracturing

The degree of fracturing or brokenness of a rock is described by measuring the fractures or joint spacing. After eliminating drilling breaks, the average spacing is calculated and the fracturing is described by the following terms:

- Very broken (V. BR.) Less than 2-inch spacing between fractures
- Broken (BR.) 2-inch to 1-foot spacing between fractures
- Blocky (BL.) 1- to 3-foot spacing between fractures
- Massive (M.) 3 to 10-foot spacing between fractures

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The structural integrity of the rock can be approximated by calculating the Rock Quality Designation (RQD) of cores recovered. The RQD is determined by adding the total lengths of all pieces exceeding 4 inches and dividing by the total length of the coring run, to obtain a percentage.

Method of Calculating RQD (After Deere, 1964)

 $RQD \% = r/l \times 100$

- r = Total length of all pieces of the lithologic unit being measured, which are greater than 4 inches length, and have resulted from natural breaks. Natural breaks include slickensides, joints, compaction slicks, bedding plane partings (not caused by drilling), friable zones, etc.
- I = Total length of the coring run.

5.3.6 Weathering

The degree of weathering is a significant parameter that is important in determining weathering profiles and is also useful in engineering designs. The following terms can be applied to distinguish the degree of weathering:

- Fresh Rock shows little or no weathering effect. Fractures or joints have little or no staining and rock has a bright appearance.
- Slight Rock has some staining which may penetrate several centimeters into the rock. Clay filling of joints may occur. Feldspar grains may show some alteration.
- Moderate Most of the rock, with exception of quartz grains, is stained. Rock is weakened due to weathering and can be easily broken with hammer.
- Severe All rock including quartz grains is stained. Some of the rock is weathered to the extent of becoming a soil. Rock is very weak.

5.3.7 Other Characteristics

The following items shall be included in the rock description:

- Description of contact between two rock units. These can be sharp or gradational.
- Stratification (parallel, cross stratified).
- Description of any filled cavities or vugs.
- Cementation (calcareous, siliceous, hematitic).
- Description of any joints or open fractures.
- Observation of the presence of fossils.
- Notation of joints with depth, approximate angle to horizontal, any mineral filling or coating, and degree of weathering.

All information shown on the boring logs shall be neat to the point where it can be reproduced on a copy machine for report presentation. The data shall be kept current to provide control of the drilling program and to indicate various areas requiring special consideration and sampling.

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5.3.8 Additional Terms Used in the Description of Rock

The following terms are used to further identify rocks:

- Seam Thin (12 inches or less), probably continuous layer.
- Some Indicates significant (15 to 40 percent) amounts of the accessory material. For example, rock composed of seams of sandstone (70 percent) and shale (30 percent) would be "sandstone -- some shale seams."
- Few Indicates insignificant (0 to 15 percent) amounts of the accessory material. For example, rock composed of seam of sandstone (90 percent) and shale (10 percent) would be "sandstone -- few shale seams."
- Interbedded Used to indicate thin or very thin alternating seams of material occurring in approximately equal amounts. For example, rock composed of thin alternating seams of sandstone (50 percent) and shale (50 percent) would be "interbedded sandstone and shale."
- Interlayered Used to indicate thick alternating seams of material occurring in approximately equal amounts.

The preceding sections describe the classification of sedimentary rocks. The following are some basic names that are applied to igneous rocks:

- Basalt A fine-grained extrusive rock composed primarily of calcic plagioclase and pyroxene.
- Rhyolite A fine-grained volcanic rock containing abundant quartz and orthoclase. The fine-grained equivalent of a granite.
- Granite A coarse-grained plutonic rock consisting essentially of alkali feldspar and quartz.
- Diorite A coarse-grained plutonic rock consisting essentially of sodic plagioclase and hornblende.
- Gabbro A coarse-grained plutonic rock consisting of calcic plagioclase and clinopyroxene. Loosely used for any coarse-grained dark igneous rock.

The following are some basic names that are applied to metamorphic rocks:

- Slate A very fine-grained foliated rock possessing a well developed slaty cleavage. Contains predominantly chlorite, mica, quartz, and sericite.
- Phyllite A fine-grained foliated rock that splits into thin flaky sheets with a silky sheen on cleavage surface.
- Schist A medium to coarse-grained foliated rock with subparallel arrangement of the micaceous minerals which dominate its composition.
- Gneiss A coarse-grained foliated rock with bands rich in granular and platy minerals.
- Quartzite A fine- to coarse-grained nonfoliated rock breaking across grains, consisting essentially of quartz sand with silica cement.

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5.4 Abbreviations

Abbreviations may be used in the description of a rock or soil. However, they shall be kept at a minimum. Following are some of the abbreviations that may be used:

С	-	Coarse	Lt	-	Light	YI	-	Yellow
Med	-	Medium	BR	-	Broken	Or	-	Orange
F	-	Fine	BL	-	Blocky	SS	-	Sandstone
V	-	Very	М	-	Massive	Sh	-	Shale
SI	-	Slight	Br	-	Brown	LS	-	Limestone
Осс	-	Occasional	ВІ	-	Black	Fgr	-	Fine-grained
Tr	-	Trace						

5.5 Boring Logs and Documentation

This section describes in more detail the procedures to be used in completing boring logs in the field. Information obtained from the preceding sections shall be used to complete the logs. A sample boring log has been provided as Figure 5.

The field geologist/engineer shall use this example as a guide in completing each boring log. Each boring log shall be fully described by the geologist/engineer as the boring is being drilled. Every sheet contains space for 25 feet of log. Information regarding classification details is provided either on the back of the boring log or on a separate sheet, for field use.

5.5.1 Soil Classification

- Identify site name, boring number, job number, etc. Elevations and water level data to be entered when surveyed data is available.
- Enter sample number (from SPT) under appropriate column. Enter depth sample was taken from (1 block = 1 foot). Fractional footages, i.e., change of lithology at 13.7 feet, shall be lined off at the proportional location between the 13- and 14-foot marks. Enter blow counts (Standard Penetration Resistance) diagonally (as shown). Standard penetration resistance is covered in Section 5.2.3.
- Determine sample recovery/sample length as shown. Measure the total length of sample recovered from the split-spoon sampler, including material in the drive shoe. Do not include cuttings or wash material that may be in the upper portion of the sample tube.
- Indicate any change in lithology by drawing a line at the appropriate depth. For example, if clayey silt
 was encountered from 0 to 5.5 feet and shale from 5.5 to 6.0 feet, a line shall be drawn at this
 increment. This information is helpful in the construction of cross-sections. As an alternative,
 symbols may be used to identify each change in lithology.
- The density of granular soils is obtained by adding the number of blows for the last two increments.
 Refer to Density of Granular Soils Chart on back of log sheet. For consistency of cohesive soils refer
 also to the back of log sheet Consistency of Cohesive Soils. Enter this information under the
 appropriate column. Refer to Section 5.2.3.

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- Enter color of the material in the appropriate column.
- Describe material using the USCS. Limit this column for sample description only. The predominant material is described last. If the primary soil is silt but has fines (clay) - use clayey silt. Limit soil descriptors to the following:

Trace: 0 - 10 percent
 Some: 11 - 30 percent
 And/Or: 31 - 50 percent

- Also indicate under Material Classification if the material is fill or natural soils. Indicate roots, organic material, etc.
- Enter USCS symbol use chart on back of boring log as a guide. If the soils fall into one of two basic groups, a borderline symbol may be used with the two symbols separated by a slash. For example ML/CL or SM/SP.
- The following information shall be entered under the "Remarks" column and shall include, but is not limited by, the following:
 - Moisture estimate moisture content using the following terms dry, moist, wet and saturated. These terms are determined by the individual. Whatever method is used to determine moisture, be consistent throughout the log.
 - Angularity describe angularity of coarse grained particles using the terms angular, subangular, subrounded, or rounded. Refer to ASTM D 2488 or Earth Manual for criteria for these terms.
 - Particle shape flat, elongated, or flat and elongated.
 - Maximum particle size or dimension.
 - Water level observations.
 - Reaction with HCI none, weak, or strong.
- Additional comments:
 - Indicate presence of mica, caving of hole, when water was encountered, difficulty in drilling, loss or gain of water.
 - Indicate odor and Photoionization Detector (PID) or Flame Ionization Detector (FID) reading if applicable.
 - Indicate any change in lithology by drawing a line through the lithology change column and indicate the depth. This will help when cross-sections are subsequently constructed.
 - At the bottom of the page indicate type of rig, drilling method, hammer size and drop, and any other useful information (i.e., borehole size, casing set, changes in drilling method).

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- Vertical lines shall be drawn (as shown in Figure 5) in columns 6 to 8 from the bottom of each sample to the top of the next sample to indicate consistency of material from sample to sample, if the material is consistent. Horizontal lines shall be drawn if there is a change in lithology, then vertical lines drawn to that point.
- Indicate screened interval of well, as needed, in the lithology column. Show top and bottom of screen. Other details of well construction are provided on the well construction forms.

5.5.2 Rock Classification

- Indicate depth at which coring began by drawing a line at the appropriate depth. Indicate core run depths by drawing coring run lines (as shown) under the first and fourth columns on the log sheet. Indicate RQD, core run number, RQD percent, and core recovery under the appropriate columns.
- Indicate lithology change by drawing a line at the appropriate depth as explained in Section 5.5.1.
- Rock hardness is entered under designated column using terms as described on the back of the log or as explained earlier in this section.
- Enter color as determined while the core sample is wet; if the sample is cored by air, the core shall be scraped clean prior to describing color.
- Enter rock type based on sedimentary, igneous or metamorphic. For sedimentary rocks use terms as described in Section 5.3. Again, be consistent in classification. Use modifiers and additional terms as needed. For igneous and metamorphic rock types use terms as described in Sections 5.3.8.
- Enter brokenness of rock or degree of fracturing under the appropriate column using symbols VBR, BR, BL, or M as explained in Section 5.3.5 and as noted on the back of the Boring Log.
- The following information shall be entered under the remarks column. Items shall include but are not limited to the following:
 - Indicate depths of joints, fractures and breaks and also approximate to horizontal angle (such as high, low), i.e., 70° angle from horizontal, high angle.
 - Indicate calcareous zones, description of any cavities or vugs.
 - Indicate any loss or gain of drill water.
 - Indicate drop of drill tools or change in color of drill water.
- Remarks at the bottom of Boring Log shall include:
 - Type and size of core obtained.
 - Depth casing was set.
 - Type of rig used.
- As a final check the boring log shall include the following:
 - Vertical lines shall be drawn as explained for soil classification to indicate consistency of bedrock material.
 - If applicable, indicate screened interval in the lithology column. Show top and bottom of screen. Other details of well construction are provided on the well construction forms.

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5.5.3 Classification of Soil and Rock from Drill Cuttings

The previous sections describe procedures for classifying soil and rock samples when cores are obtained. However, some drilling methods (air/mud rotary) may require classification and borehole logging based on identifying drill cuttings removed from the borehole. Such cuttings provide only general information on subsurface lithology. Some procedures that shall be followed when logging cuttings are:

- Obtain cutting samples at approximately 5-foot intervals, sieve the cuttings (if mud rotary drilling) to
 obtain a cleaner sample, place the sample into a small sample bottle or "zip lock" bag for future
 reference, and label the jar or bag (i.e. hole number, depth, date, etc.). Cuttings shall be closely
 examined to determine general lithology.
- Note any change in color of drilling fluid or cuttings, to estimate changes in lithology.
- Note drop or chattering of drilling tools or a change in the rate of drilling, to determine fracture locations or lithologic changes.
- Observe loss or gain of drilling fluids or air (if air rotary methods are used), to identify potential fracture zones.
- Record this and any other useful information onto the boring log as provided in Figure 1.

This logging provides a general description of subsurface lithology and adequate information can be obtained through careful observation of the drilling process. It is recommended that split-barrel and rock core sampling methods be used at selected boring locations during the field investigation to provide detailed information to supplement the less detailed data generated through borings drilled using air/mud rotary methods.

5.6 Review

Upon completion of the borings logs, copies shall be made and reviewed. Items to be reviewed include:

- Checking for consistency of all logs.
- Checking for conformance to the guideline.
- Checking to see that all information is entered in their respective columns and spaces.

6.0 REFERENCES

Unified Soil Classification System (USCS).

ASTM D2488, 1985.

Earth Manual, U.S. Department of the Interior, 1974.

7.0 RECORDS

Originals of the boring logs shall be retained in the project files.



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STANDARD OPERATING PROCEDURES

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Applicability

Tetra Tech NUS, Inc.

Prepared

Earth Sciences Department

Approved

D. Senovich

Subject

SOIL AND ROCK DRILLING METHODS

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1.0 PURPOSE

The purpose of this procedure is to describe the methods and equipment necessary to perform soil and rock borings and identify the equipment, sequence of events, and appropriate methods necessary to obtain soil, both surface and subsurface, and rock samples during field sampling activities.

2.0 SCOPE

This guideline addresses most of the accepted and standard drilling techniques, their benefits, and drawbacks. It should be used generally to determine what type of drilling techniques would be most successful depending on site-specific geologic conditions and the type of sampling required.

The sampling methods described within this procedure are applicable to collecting surface and subsurface soil samples, and obtaining rock core samples for lithologic and hydrogeologic evaluation, excavation/foundation design, remedial alternative design and related civil engineering purposes.

3.0 GLOSSARY

Rock Coring - A method in which a continuous solid cylindrical sample of rock or compact rock-like soil is obtained by the use of a double tube core barrel that is equipped with an appropriate diamond-studded drill bit which is advanced with a hydraulic rotary drilling machine.

<u>Wire-Line Coring</u> - As an alternative to conventional coring, this technique is valuable in deep hole drilling, since this method eliminates trips in and out of the hole with the coring equipment. With this technique, the core barrel becomes an integral part of the drill rod string. The drill rod serves as both a coring device and casing.

4.0 RESPONSIBILITIES

<u>Project Manager</u> - In consultation with the project geologist, the Project Manager is responsible for evaluating the drilling requirements for the site and specifying drilling techniques that will be successful given the study objectives and the known or suspected geologic conditions at the site. The Project Manager also determines the disposal methods for products generated by drilling, such as drill cuttings and well development water, as well as any specialized supplies or logistical support required for the drilling operations.

<u>Field Operations Leader (FOL)</u> - The FOL is responsible for the overall supervision and scheduling of drilling activities, and is strongly supported by the project geologist.

<u>Project Geologist</u> - The project geologist is responsible for ensuring that standard and approved drilling procedures are followed. The geologist will generate a detailed boring log for each test hole. This log shall include a description of materials, samples, method of sampling, blow counts, and other pertinent drilling and testing information that may be obtained during drilling (see SOPs SA-6.3 and GH-1.5). Often this position for inspecting the drilling operations may be filled by other geotechnical personnel, such as soils and foundation engineers, civil engineers, etc.

Determination of the exact location for borings is the responsibility of the site geologist. The final location for drilling must be properly documented on the boring log. The general area in which the borings are to be located will be shown on a site map included in the Work Plan and/or Sampling and Analysis Plan.

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<u>Drilling Subcontractor</u> - Operates under the supervision of the FOL. Responsible for obtaining all drilling permits and clearances, and supplying all services (including labor), equipment and material required to perform the drilling, testing, and well installation program, as well as maintenance and quality control of such required equipment except as stated in signed and approved subcontracts.

The driller must report any major technical or analytical problems encountered in the field to the FOL within 24 hours of determination, and must provide advance written notification of any changes in field procedures, describing and justifying such changes. No such changes shall be made unless requested and authorized in writing by the FOL (with the concurrence of the Project Manager). Depending on the subcontract, the Project Manager may need to obtain written authorization from appropriate administrative personnel before approving any changes.

The drilling subcontractor is responsible for following decontamination procedures specified in the project plan documents. Upon completion of the work, the driller is responsible for demobilizing all equipment, cleaning up any materials deposited on site during drilling operations, and properly backfilling any open borings.

5.0 PROCEDURES

5.1 General

The purpose of drilling boreholes is:

- To determine the type, thickness, and certain physical and chemical properties of the soil, water and rock strata which underlie the site.
- To install monitoring wells or piezometers.

All drilling and sampling equipment will be cleaned between samples and borings using appropriate decontamination procedures as outlined in SOP SA-7.1. Unless otherwise specified, it is generally advisable to drill borings at "clean" locations first, and at the most contaminated locations last, to reduce the risk of spreading contamination between locations. All borings must be logged by the site geologist as they proceed (see SOPs SA-6.3 and GH-1.5). Situations where logging would not be required would include installation of multiple well points within a small area, or a "second attempt" boring adjacent to a boring that could not be continued through resistant material. In the latter case, the boring log can be resumed 5 feet above the depth at which the initial boring was abandoned, although the site geologist should still confirm that the stratigraphy at the redrilled location conforms essentially with that encountered at the original location. If significant differences are seen, each hole should be logged separately.

5.2 Drilling Methods

The selected drilling methods described below apply to drilling in subsurface materials, including, but not limited to, sand, gravel, clay, silt, cobbles, boulders, rock and man-made fill. Drilling methods should be selected after studying the site geology and terrain, the waste conditions at the site, and reviewing the purpose of drilling and the overall subsurface investigation program proposed for the site. The full range of different drilling methods applicable to the proposed program should be identified with final selection based on relative cost, availability, time constraints, and how well each method meets the sampling and testing requirements of the individual drilling program.

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5.2.1 Continuous-Flight Hollow-Stem Auger Drilling

This method of drilling consists of rotating augers with a hollow stem into the ground. Cuttings are brought to the surface by the rotating action of the auger. This method is relatively quick and inexpensive. Advantages of this type of drilling include:

- Samples can be obtained without pulling the augers out of the hole. However, this is a poor method
 for obtaining grab samples from thin, discrete formations because of mixing of soils which occurs as
 the material is brought to the surface. Sampling of such formations requires the use of split-barrel or
 thin-wall tube samplers advanced through the hollow core of the auger.
- No drilling fluids are required.
- A well can be installed inside the auger stem and backfilled as the augers are withdrawn.

Disadvantages and limitations of this method of drilling include:

- Augering can only be done in unconsolidated materials.
- The inside diameter of hollow stem augers used for well installation should be at least 4 inches greater than the well casing. Use of such large-diameter hollow-stem augers is more expensive than the use of small-diameter augers in boreholes not used for well installation. Furthermore, the density of unconsolidated materials and depths become more of a limiting factor. More friction is produced with the larger diameter auger and subsequently greater torque is needed to advance the boring.
- The maximum effective depth for drilling is 150 feet or less, depending on site conditions and the size of augers used.
- In augering through clean sand formations below the water table, the sand will tend to flow into the
 hollow stem when the plug is removed for soil sampling or well installation. If the condition of
 "running" or "flowing" sands is persistent at a site, an alternative method of drilling is recommended,
 in particular for wells or boreholes deeper than 25 feet.

Hollow-stem auger drilling is the preferred method of drilling. Most alternative methods require the introduction of water or mud downhole (air rotary is the exception) to maintain the open borehole. With these other methods, great care must be taken to ensure that the method does not interfere with the collection of a representative sample (which may be the prime objective of the borehole construction). With this in mind, the preferred order of choice of drilling method after hollow-stem augering (HSA) is:

- Cable tool
- Casing drive (air)
- Air rotary
- Mud rotary
- Rotosonic
- Drive and wash
- Jetting

However, the use of any method will also depend on efficiency and cost-effectiveness. In many cases, mud rotary is the only feasible alternative to hollow-stem augering. Thus, mud rotary drilling is generally acceptable as a first substitute for HSA.

The procedures for sampling soils through holes drilled by hollow-stem auger shall conform with the applicable ASTM Standards: D1587-83 and D1586-84. The guidelines established in SOP SA-1.3 shall

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also be followed. The hollow-stem auger may be advanced by any power-operated drilling machine having sufficient torque and ram range to rotate and force the auger to the desired depth. The machine must, however, be equipped with the accessory equipment needed to perform required sampling, or rock coring.

The hollow-stem auger may be used without the plug when boring for geotechnical examination or for well installation. However, when drilling below the water table, specially designed plugs which allow passage of formation water but not solid material shall be used (see Reference 1 of this guideline). This drilling configuration method also prevents blow back and plugging of the auger when the plug is removed for sampling.

Alternately, it may be necessary to keep the hollow stem full of water, at least to the level of the water table, to prevent blowback and plugging of the auger. If water is added to the hole, it must be sampled and analyzed to determine if it is free from contaminants prior to use. In addition, the amount of water introduced, the amount recovered upon attainment of depth, and the amount of water extracted during well development must be carefully logged in order to ensure that a representative sample of the formation water can be obtained. Well development should occur as soon after well completion as practicable (see SOP GH-2.8 for well development procedures). If gravelly or hard material is encountered which prevents advancing the auger to the desired depth, augering should be halted and either driven casing or hydraulic rotary methods should be attempted. If the depth to the bedrock/soil interface and bedrock lithology must be determined, then a 5-foot confirmatory core run should be conducted (see Section 5.2.9).

At the option of the Field Operations Leader (in communication with the Project Manager), when resistant materials prevent the advancement of the auger, a new boring can be attempted. The original boring must be properly backfilled and the new boring started a short distance away at a location determined by the site geologist. If multiple water bearing strata were encountered, the original boring must be grouted. In some formations, it may be prudent to also grout borings which penetrate only the water table aquifer, since loose soil backfill in the boring may still provide a preferred pathway for surface liquids to reach the water table. Backfilling requirements may also be driven by state or local regulations.

5.2.2 Continuous-Flight Solid-Stem Auger Drilling

This drilling method is similar to hollow-stem augering. Practical application of this method is severely restricted compared to use of hollow-stem augers. Split-barrel (split-spoon) sampling cannot be performed without pulling the augers out, which may allow the hole to collapse. The continuous-flight solid-stem auger drilling method is therefore very time consuming and is not cost effective. Also, augers would have to be withdrawn before installing a monitoring well, which again, may allow the hole to collapse. Furthermore, geologic logging by examining the soils brought to the surface is unreliable, and depth to water may be difficult to determine while drilling.

There would be very few situations where use of a solid-stem auger would be preferable to other drilling methods. The only practical applications of this method would be to drill boreholes for well installation where no lithologic information is desired and the soils are such that the borehole can be expected to remain open after the augers are withdrawn. Alternatively, this technique can be used to find depth to bedrock in an area when no other information is required from drilling.

5.2.3 Rotary Drilling

Direct rotary drilling includes air-rotary and fluid-rotary drilling. For air or fluid-rotary drilling, the rotary drill may be advanced to the desired depth by any power-operated drilling machine having sufficient torque

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and ram range to rotate and force the bit to the desired depth. The drilling machine must, however, be equipped with any accessory equipment needed to perform required sampling, or coring. Prior to sampling, any settled drill cuttings in the borehole must be removed.

Air-rotary drilling is a method of drilling where the drill rig simultaneously turns and exerts a downward pressure on the drilling rods and bit while circulating compressed air down the inside of the drill rods, around the bit, and out the annulus of the borehole. Air circulation serves to both cool the bit and remove the cuttings from the borehole. Advantages of this method include:

- The drilling rate is high (even in rock).
- The cost per foot of drilling is relatively low.
- Air-rotary rigs are common in most areas.
- No drilling fluid is required (except when water is injected to keep down dust).
- The borehole diameter is large, to allow room for proper well installation procedures.

Disadvantages to using this method include:

- Formations must be logged from the cuttings that are blown to the surface and thus the depths of materials logged are approximate.
- Air blown into the formation during drilling may "bind" the formation and impede well development and natural groundwater flow.
- In-situ samples cannot be taken, unless the hole is cased.
- Casing must generally be used in unconsolidated materials.
- Air-rotary drill rigs are large and heavy.
- Large amounts of Investigation Derived Waste (IDW) may be generated which may require containerization, sampling, and off-site disposal.

A variation of the typical air-rotary drill bit is a down hole hammer which hammers the drill bit down as it drills. This makes drilling in hard rock faster. Air-rotary drills can also be adapted to use for rock coring although they are generally slower than other types of core drills. A major application of the air-rotary drilling method would be to drill holes in rock for well installation.

Fluid-Rotary drilling operates in a similar manner to air-rotary drilling except that a drilling fluid ("mud") or clean water is used in place of air to cool the drill bit and remove cuttings. There are a variety of fluids that can be used with this drilling method, including bentonite slurry and synthetic slurries. If a drilling fluid other than water/cuttings is used, it must be a natural clay (i.e., bentonite) and a "background" sample of the fluid should be taken for analysis of possible organic or inorganic contaminants.

Advantages to the fluid-rotary drilling method include:

- The ability to drill in many types of formations.
- Relatively quick and inexpensive.
- Split-barrel (split-spoon) or thin-wall (Shelby) tube samples can be obtained without removing drill
 rods if the appropriate size drill rods and bits (i.e., fish-tail or drag bit) are used.

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- In some borings temporary casing may not be needed as the drilling fluids may keep the borehole open.
- Drill rigs are readily available in most areas.

Disadvantages to this method include:

- Formation logging is not as accurate as with hollow-stem auger method if split-barrel (split-spoon) samples are not taken (i.e., the depths of materials logged from cuttings delivered to the surface are approximate).
- Drilling fluids reduce permeability of the formation adjacent to the boring to some degree, and require
 more extensive well development than "dry" techniques (augering, air-rotary).
- No information on depth to water is obtainable while drilling.
- Fluids are needed for drilling, and there is some question about the effects of the drilling fluids on subsequent water samples obtained. For this reason as well, extensive well development may be required.
- In very porous materials (i.e., rubble fill, boulders, coarse gravel) drilling fluids may be continuously lost into the formation. This requires either constant replenishment of the drilling fluid, or the use of casing through this formation.
- Drill rigs are large and heavy, and must be supported with supplied water.
- Groundwater samples can be potentially diluted with drilling fluid.

The procedures for performing direct rotary soil investigations and sampling shall conform with the applicable ASTM standards: D2113-83, D1587-83, and D1586-84.

Soil samples shall be taken as specified by project plan documents, or more frequently, if requested by the project geologist. Any required sampling shall be performed by rotation, pressing, or driving in accordance with the standard or approved method governing use of the particular sampling tool.

When field conditions prevent the advancement of the hole to the desired depth, a new boring may be drilled at the request of the Field Operations Leader. The original boring shall be backfilled using methods and materials appropriate for the given site and a new boring started a short distance away at a location determined by the project geologist.

5.2.4 Rotosonic Drilling

The Rotosonic drilling method employs a high frequency vibrational and low speed rotational motion coupled with down pressure to advance the cutting edge of a drill string. This produces a uniform borehole while providing a continuous, undisturbed core sample of both unconsolidated and most bedrock formations. Rotosonic drilling advances a 4-inch diameter to 12-inch diameter core barrel for sampling and can advance up to a 12-inch diameter outer casing for the construction of standard and telescoped monitoring wells. During drilling, the core barrel is advanced ahead of the outer barrel in increments as determined by the site geologist and depending upon type of material, degree of subsurface contamination and sampling objectives.

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The outer casing can be advanced at the same time as the inner drill string and core barrel, or advanced down over the inner drill rods and core barrel, or after the core barrel has moved ahead to collect the undisturbed sample and has been pulled out of the borehole. The outer casing can be advanced dry in most cases, or can be advanced with water or air depending upon the formations being drilled, the depth and diameter of the hole, or requirements of the project.

Advantages of this method include:

- Sampling and well installation are faster as compared to other drilling methods.
- Continuous sampling, with larger sample volume as compared to split-spoon sampling.
- The ability to drill through difficult formations such as cobbles or boulders, hard till and bedrock.
- Reduction of IDW by an average of 70 to 80 percent.
- Well installations are quick and controlled by elimination of potential bridging of annular materials during well installation, due to the ability to vibrate the outer casing during removal.

Disadvantages include:

- The cost for Rotosonic drilling as compared to other methods are generally higher. However, the net result can be a significant savings considering reduced IDW and shortened project duration.
- Rotosonic drill rigs are large and need ample room to drill, however, Rotosonic units can be placed on the ground or placed on an ATV.
- There are a limited number of Rotosonic drilling contractors at the present time.

5.2.5 Reverse Circulation Rotary Drilling

The common reverse-circulation rig is a water or mud-rotary rig with a large-diameter drill pipe which circulates the drilling water down the annulus and up the inside of the drill pipe (reverse flow direction from direct mud-rotary). This type of rig is used for the construction of large-capacity production water wells and is not suited for small, water quality sampling wells because of the use of drilling muds and the large-diameter hole which is created. A few special reverse-circulation rotary rigs are made with double-wall drill pipe. The drilling water or air is circulated down the annulus between the drill pipes and up inside the inner pipe.

Advantages of the latter method include:

- The formation water is not contaminated by the drilling water.
- Formation samples can be obtained, from known depths.
- When drilling with air, immediate information is available regarding the water-bearing properties of formations penetrated.
- Collapsing of the hole in unconsolidated formations is not as great a problem as when drilling with the normal air-rotary rig.

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Disadvantages include:

- Double-wall, reverse-circulation drill rigs are rare and expensive to operate.
- Placing cement grout around the outside of the well casing above a well screen often is difficult, especially when the screen and casing are placed down through the inner drill pipe before the drill pipe is pulled out.

5.2.6 Drill-through Casing Driver

The driven-casing method consists of alternately driving casing (fitted with a sharp, hardened casing shoe) into the ground using a hammer lifted and dropped by the drill rig (or an air-hammer) and cleaning out the casing using a rotary chopping bit and air or water to flush out the materials. The casing is driven down in stages (usually 5 feet per stage); a continuous record is kept of the blows per foot in driving the casing (see SOP GH-1.5). The casing is normally advanced by a 300-pound hammer falling freely through a height of 30 inches. Simultaneous washing and driving of the casing is not recommended. If this procedure is used, the elevations within which wash water is used and in which the casing is driven must be clearly recorded.

The driven casing method is used in unconsolidated formations only. When the boring is to be used for later well installation, the driven casing used should be at least 4 inches larger in diameter than the well casing to be installed. Advantages to this method of drilling include:

- Split-barrel (split-spoon) sampling can be conducted while drilling.
- Well installation is easily accomplished.
- Drill rigs used are relatively small and mobile.
- The use of casing minimizes flow into the hole from upper water-bearing layers, therefore, multiple
 aquifers can be penetrated and sampled for rough field determinations of some water quality
 parameters.

Some of the disadvantages include:

- This method can only be used in unconsolidated formations.
- The method is slower than other methods (average drilling progress is 30 to 50 feet per day).
- Maximum depth of the borehole varies with the size of the drill rig and casing diameter used, and the nature of the formations drilled.
- The cost per hour or per foot of drilling may be substantially higher than other drilling methods.
- It is difficult and time consuming to pull back the casing if it has been driven very deep (deeper than 50 feet in many formations).

5.2.7 Cable Tool Drilling

A cable tool rig uses a heavy, solid-steel, chisel-type drill bit ("tool") suspended on a steel cable, which when raised and dropped, chisels or pounds a hole through the soils and rock. Drilling progress may be

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expedited by the use of "slip-jars" which serve as a cable-activated down hole percussion device to hammer the bit ahead.

When drilling through the unsaturated zone, some water must be added to the hole. The cuttings are suspended in the water and then bailed out periodically. Below the water table, after sufficient ground water enters the borehole to replace the water removed by bailing, no further water needs to be added. When soft caving formations are encountered, it is usually necessary to drive casing as the hole is advanced to prevent collapse of the hole. Often the drilling can be only a few feet below the bottom of the casing. Because the drill bit is lowered through the casing, the hole created by the bit is smaller than the casing. Therefore, the casing (with a sharp, hardened casing shoe on the bottom) must be driven into the hole (see Section 5.2.5 of this guideline).

Advantages of the cable-tool method include the following:

- Information regarding water-bearing zones is readily available during the drilling. Even relative
 permeabilities and rough water quality data from different zones penetrated can be obtained by skilled
 operators.
- The cable-tool rig can operate satisfactorily in all formations, but is best suited for caving, boulder, cobble or coarse gravel type formations (e.g., glacial till) or formations with large cavities above the water table (such as limestones).
- When casing is used, the casing seals formation water out of the hole, preventing down hole contamination and allowing sampling of deeper aquifers for field-measurable water quality parameters.
- Split-barrel (split-spoon) or thin-wall (Shelby) tube samples can be collected through the casing.

Disadvantages include:

- Drilling is slow compared with rotary rigs.
- The necessity of driving the casing in unconsolidated formations requires that the casing be pulled back if exposure of selected water-bearing zones is desired. This process complicates the well completion process and often increases costs. There is also a chance that the casing may become stuck in the hole.
- The relatively large diameters required (minimum of 4-inch casing) plus the cost of steel casing result
 in higher costs compared to rotary drilling methods where casing is not required (e.g., such use of a
 hollow-stem auger).
- Cable-tool rigs have largely been replaced by rotary rigs. In some parts of the U.S., availability may
 be difficult.

5.2.8 Jet Drilling (Washing)

Jet drilling, which should be used only for piezometer or vadose zone sampler installation, consists of pumping water or drilling mud down through a small diameter (1/2- to 2-inch) standard pipe (steel or PVC). The pipe may be fitted with a chisel bit or a special jetting screen. Formation materials dislodged by the bit and jetting action of the water are brought to the surface through the annulus around the pipe. As the pipe is jetted deeper, additional lengths of pipe may be added at the surface.

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Jet percussion is a variation of the jetting method, in which the casing is driven with a drive weight. Normally, this method is used to place 2-inch-diameter casing in shallow, unconsolidated sand formations, but this method has also been used to install 3- to 4-inch-diameter casings to a depth of 200 feet.

Jetting is acceptable in very soft formations, usually for shallow sampling, and when introduction of drilling water to the formation is acceptable. Such conditions would occur during rough stratigraphic investigation or installation of piezometers for water level measurement. Advantages of this method include:

- Jetting is fast and inexpensive.
- Because of the small amount of equipment required, jetting can be accomplished in locations where
 access by a normal drilling rig would be very difficult. For example, it would be possible to jet down a
 well point in the center of a lagoon at a fraction of the cost of using a drill rig.
- Jetting numerous well points just into a shallow water table is an inexpensive method for determining the water table contours, hence flow direction.

Disadvantages include the following:

- A large amount of foreign water or drilling mud is introduced above and into the formation to be sampled.
- Jetting is usually done in very soft formations which are subject to caving. Because of this caving, it
 is often not possible to place a grout seal above the screen to assure that water in the well is only
 from the screened interval.
- The diameter of the casing is usually limited to 2 inches.
- Jetting is only possible in very soft formations that do not contain boulders or coarse gravel, and the depth limitation is shallow (about 30 feet without jet percussion equipment).
- Large quantities of water are often needed.

5.2.9 Drilling with a Hand Auger

This method is applicable wherever the formation, total depth of sampling, and the site and groundwater conditions are such as to allow hand auger drilling. Hand augering can also be considered at locations where drill rig access is not possible. All hand auger borings will be performed according to ASTM D1452-80.

Samples should be taken continuously unless otherwise specified by the project plan documents. Any required sampling is performed by rotation, pressing, or driving in accordance with the standard or approved method governing use of the particular sampling tool. Typical equipment used for sampling and advancing shallow "hand auger" holes are Iwan samplers (which are rotated) or post hole diggers (which are operated like tongs). These techniques are slow but effective where larger pieces of equipment do not have access, and where very shallow holes are desired (less than 15 feet). Surficial soils must be composed of relatively soft and non-cemented formations to allow penetration by the auger.

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5.2.10 Rock Drilling and Coring

When soil borings cannot be continued using augers or rotary methods due to the hardness of the soil or when rock or large boulders are encountered, drilling and sampling can be performed using a diamond bit corer in accordance with ASTM D2113.

Drilling is done by rotating and applying downward pressure to the drill rods and drill bit. The drill bit is a circular, hollow, diamond-studded bit attached to the outer core barrel in a double-tube core barrel. The use of single-tube core barrels is not recommended, as the rotation of the barrel erodes the sample and limits its use for detailed geological evaluation. Water or air is circulated down through the drill rods and annular space between the core barrel tubes to cool the bit and remove the cuttings. The bit cuts a core out of the rock which rises into an inner barrel mounted inside the outer barrel. The inner core barrel and rock core are removed by lowering a wire line with a coupling into the drill rods, latching onto the inner barrel and withdrawing the inner barrel. A less efficient variation of this method utilizes a core barrel that cannot be removed without pulling all of the drill rods. This variation is practical only if less than 50 feet of core is required.

Core borings are made through the casing used for the soil borings. The casing must be driven and sealed into the rock formation to prevent seepage from the overburden into the hole to be cored (see Section 5.3 of this guideline). A double-tube core barrel with a diamond bit and reaming shell or equivalent should be used to recover rock cores of a size specified in the project plans. The most common core barrel diameters are listed in Attachment A.

Soft or decomposed rock should be sampled with a driven split-barrel whenever possible or cored with a Denison or Pitcher sampler.

When coring rock, including shale and claystone, the speed of the drill and the drilling pressure, amount and pressure of water, and length of run can be varied to give the maximum recovery from the rock being drilled. Should any rock formation be so soft or broken that the pieces continually fall into the hole causing unsatisfactory coring, the hole should be reamed and a flush-joint casing installed to a point below the broken formation. The size of the flush-joint casing must permit securing the core size specified. When soft or broken rock is anticipated, the length of core runs should be reduced to less than 5 feet to avoid core loss and minimize core disturbance.

Advantages of core drilling include:

- Undisturbed rock cores can be recovered for examination and/or testing.
- In formations in which the cored hole will remain open without casing, water from the rock fractures may be recovered from the well without the installation of a well screen and gravel pack.
- Formation logging is extremely accurate.
- Drill rigs are relatively small and mobile.

Disadvantages include:

- Water or air is needed for drilling.
- Coring is slower than rotary drilling (and more expensive).
- Depth to water cannot accurately be determined if water is used for drilling.
- The size of the borehole is limited.

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This drilling method is useful if accurate determinations of rock lithology are desired or if open wells are to be installed into bedrock. To install larger diameter wells in coreholes, the hole must be reamed out to the proper size after boring, using air or mud rotary drilling methods.

5.2.11 Drilling & Support Vehicles

In addition to the drilling method required to accomplish the objectives of the field program, the type of vehicle carrying the drill rig and/or support equipment and its suitability for the site terrain, will often be an additional deciding factor in planning the drilling program. The types of vehicles available are extensive, and depend upon the particular drilling subcontractor's fleet. Most large drilling subcontractors will have a wide variety of vehicle and drill types suited for most drilling assignments in their particular region, while smaller drilling subcontractors will usually have a fleet of much more limited diversity. The weight, size, and means of locomotion (tires, tracks, etc.) of the drill rig must be selected to be compatible with the site terrain to assure adequate mobility between borehole locations. Such considerations also apply to necessary support vehicles used to transport water and/or drilling materials to the drill rigs at the borehole locations. When the drill rigs or support vehicles do not have adequate mobility to easily traverse the site, provisions must be made for assisting equipment, such as bulldozers, winches, timber planking, etc., to maintain adequate progress during the drilling program.

Some of the typical vehicles which are usually available for drill rigs and support equipment are:

- Totally portable drilling/sampling equipment, where all necessary components (tripods, samplers, hammers, catheads, etc.) may be hand carried to the borehole site. Drilling/sampling methods used with such equipment include:
 - Hand augers and lightweight motorized augers.
 - Retractable plug samplers--driven by hand (hammer).
 - Motorized cathead a lightweight aluminum tripod with a small gas-engine cathead mounted on one leg, used to install small-diameter cased borings. This rig is sometimes called a "monkey on a stick."
- Skid-mounted drilling equipment containing a rotary drill or engine-driven cathead (to lift hammers and drill string), a pump, and a dismounted tripod. The skid is pushed, dragged, or winched (using the cathead drum) between boring locations.
- Small truck-mounted drilling equipment using a Jeep, stake body or other light truck (4 to 6 wheels), upon which are mounted the drill and/or a cathead, a pump, and a tripod or small drilling derrick. On some rigs, the drill and/or a cathead are driven by a power take-off from the truck, instead of by a separate engine.
- Track-mounted drilling equipment is similar to truck-mounted rigs, except that the vehicle used has
 wide bulldozer tracks for traversing soft ground. Sometimes a continuous-track "all terrain vehicle" is
 also modified for this purpose. Some types of tracked drill rigs are called "bombardier" or "weasel"
 rigs.
- Heavy truck-mounted drilling equipment is mounted on tandem or dual tandem trucks to transport the drill, derrick, winches, and pumps or compressors. The drill may be provided with a separate engine or may use a power take-off from the truck engine. Large augers, hydraulic rotary and reverse circulation rotary drilling equipment are usually mounted on such heavy duty trucks. For soft-ground sites, the drilling equipment is sometimes mounted on vehicles having low pressure, very wide diameter tires and capable of floating; these vehicles are called "swamp buggy" rigs.

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- Marine drilling equipment is mounted on various floating equipment for drilling borings in lakes, estuaries and other bodies of water. The floating equipment varies, and is often manufactured or customized by the drilling subcontractor to suit specific drilling requirements. Typically, the range of flotation vehicles include:
 - Barrel-float rigs a drill rig mounted on a timber platform buoyed by empty 55-gallon drums or similar flotation units.
 - Barge-mounted drill rigs.
 - Jack-up platforms drilling equipment mounted on a floating platform having retractable legs to support the unit on the sea or lake bed when the platform is jacked up out of the water.
 - Drill ships for deep ocean drilling.

In addition to the mobility for the drilling equipment, similar consideration must be given for equipment to support the drilling operations. Such vehicles or floating equipment are needed to transport drill water, drilling supplies and equipment, samples, drilling personnel, etc. to and/or from various boring locations.

5.2.12 Equipment Sizes

In planning subsurface exploration programs, care must be taken in specifying the various drilling components, so that they will fit properly in the boring or well.

For drilling open boreholes using rotary drilling equipment, tri-cone drill bits are employed with air, water or drilling mud to remove cuttings and cool the bit. Tri-cone bits are slightly smaller than the holes they drill (i.e., 5-7/8-inch or 7-7/8-inch bits will nominally drill 6-inch and 8-inch holes, respectively).

For obtaining split-barrel samples of a formation, samplers are commonly manufactured in sizes ranging from 2 inches to 3-1/2 inches in outside diameter. However, the most commonly used size is the 2-inch O.D., 1-3/8-inch I.D. split-barrel sampler. When this sampler is used and driven by a 140-pound (\pm 2-pound) hammer dropping 30 inches (\pm 1 inch), the procedure is called a Standard Penetration Test, and the blows per foot required to advance the sampler into the formation can be correlated to the formation's density or strength.

In planning the drilling of boreholes using hollow-stem augers or casing, in which thin-wall tube samples or diamond core drilling will be performed, refer to the various sizes and clearances provided in Attachment A of this guideline. Sizes selected must be stated in the project plan documents.

5.2.13 Estimated Drilling Progress

To estimate the anticipated rates of drilling progress for a site, the following must be considered:

- The speed of the drilling method employed.
- Applicable site conditions (e.g., terrain, mobility between borings, difficult drilling conditions in bouldery soils, rubble fill or broken rock, etc.).
- Project-imposed restrictions (e.g., drilling while wearing personal protective equipment, decontamination of drilling equipment, etc.).

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Based on recent experience in drilling average soil conditions (no boulders) and taking samples at 5-foot intervals, for moderate depth (30 feet to 50 feet) boreholes (not including installation or development of wells), the following daily rates of total drilling progress may be anticipated for the following drilling methods:

Drilling Method	Average Daily Progress (linear feet)
Hollow-stem augers	75'
Solid-stem augers	50'
Mud-Rotary Drilling	100' (cuttings samples)
Rotosonic Drilling	100'-160' (continuous core)
Reverse-Circulation Rotary	100' (cuttings samples)
Skid-Rig with driven casing	30'
Rotary with driven casing	50'
Cable Tool	30'
Hand Auger	Varies
Continuous Rock Coring	50'

5.3 Prevention of Cross-Contamination

A telescoping or multiple casing technique minimizes the potential for the migration of contaminated groundwater to lower strata below a confining layer. The telescoping technique consists of drilling to a confining layer utilizing a spun casing method with a diamond cutting or augering shoe (a method similar to the rock coring method described in Section 5.2.10, except that larger casing is used) or by using a driven-casing method (see Section 5.2.6 of this guideline) and installing a specified diameter steel well casing. The operation consists of three separate steps. Initially, a drilling casing (usually of 8-inch diameter) is installed followed by installation of the well casing (6-inch-diameter is common for 2-inch wells). This well casing is driven into the confining layer to ensure a tight seal at the bottom of the hole. The well casing is sealed at the bottom with a bentonite-cement slurry. The remaining depth of the boring is drilled utilizing a narrower diameter spun or driven casing technique within the outer well casing. A smaller diameter well casing with an appropriate length of slotted screen on the lower end, is installed to the surface.

Clean sand is placed in the annulus around and to a point of about 2 feet above the screen prior to withdrawal of the drilling casing. The annular space above the screen and to a point 2 feet above the bottom of the outer well casing is sealed with a tremied cement-bentonite slurry which is pressure-grouted or displacement-grouted into the hole. The remaining casing annulus is backfilled with clean material and grouted at the surface, or it is grouted all the way to the surface.

5.4 Cleanout of Casing Prior to Sampling

The boring hole must be completely cleaned of disturbed soil, segregated coarse material and clay adhering to the inside walls of the casing. The cleaning must extend to the bottom edge of the casing and, if possible, a short distance further (1 or 2 inches) to bypass disturbed soil resulting from the advancement of the casing. Loss of wash water during cleaning should be recorded.

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For disturbed samples both above and below the water table and where introduction of relatively large volumes of wash water is permissible, the cleaning operation is usually performed by washing the material out of the casing with water; however, the cleaning should never be accomplished with a strong, downward-directed jet which will disturb the underlying soil. When clean out has reached the bottom of the casing or slightly below (as specified above), the string of tools should be lifted one foot off the bottom with the water still flowing, until the wash water coming out of the casing is clear of granular soil particles. In formations where the cuttings contain gravel and other larger particles, it is often useful to repeatedly raise and lower the drill rods and wash bit while washing out the hole, to surge these large particles upward out of the hole. As a time saver, the drilling contractor may be permitted to use a split-barrel (split-spoon) sampler with the ball check valve removed as the clean-out tool, provided the material below the spoon is not disturbed and the shoe of the spoon is not damaged. However, because the ball check valve has been removed, in some formations it may be necessary to install a flap valve or spring sample retainer in the split-spoon bit, to prevent the sample from falling out as the sampler is withdrawn from the hole. The use of jet-type chopping bits is discouraged except where large boulders and cobbles or hardcemented soils are encountered. If water markedly softens the soils above the water table, clean out should be performed dry with an auger.

For undisturbed samples below the water table, or where wash water must be minimized, clean out is usually accomplished with an appropriate diameter clean out auger. This auger has cutting blades at the bottom to carry loose material up into the auger, and up-turned water jets just above the cutting blades to carry the removed soil to the surface. In this manner, there is a minimum of disturbance at the top of the material to be sampled. If any gravel material washes down into the casing and cannot be removed by the clean out auger, a split-barrel sample can be taken to remove it; bailers and sandpumps should not be used. For undisturbed samples above the groundwater table, all operations must be performed in a dry manner.

If all of the cuttings created by drilling through the overlying formations are not cleaned from the borehole prior to sampling, some of the problems which may be encountered during sampling include:

- When sampling is attempted through the cuttings remaining in the borehole, all or part of the sampler may become filled with the cuttings. This limits the amount of sample from the underlying formation which can enter and be retained in the sampler, and also raises questions as to the validity of the sample.
- If the cuttings remaining in the borehole contain coarse gravel and/or other large particles, these may block the bit of the sampler and prevent any materials from the underlying formation from entering the sampler when the sampler is advanced.
- In cased borings, should sampling be attempted through cuttings which remain in the lower portion of the casing, these cuttings could cause the sampler to become bound into the casing, such that it becomes very difficult to either advance or retract the sampler.
- When sampler blow counts are used to estimate the density or strength of the formation being sampled, the presence of cuttings in the borehole will usually give erroneously high sample blow counts.

To confirm that all cuttings have been removed from the borehole prior to attempting sampling, it is important that the site geologist measure the "stickup" of the drill string. This is accomplished by measuring the assembled length of all drill rods and bits or samplers (the drill string) as they are lowered to the bottom of the hole, below some convenient reference point of the drill string, then measuring the height of this reference point above the ground surface. The difference of these measurements is the

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depth of the drill string (lower end of the bit or sampler) below the ground surface, which must then be compared with the depth of sampling required (installed depth of casing or depth of borehole drilled). If the length of drill string below grade is more than the drilled or casing depth, the borehole has been cleaned too deeply, and this deeper depth of sampling must be recorded on the log. If the length of drill string below grade is less than the drilled or casing depth, the difference represents the thickness of cuttings which remain in the borehole. In most cases, an inch or two of cuttings may be left in the borehole with little or no problem. However, if more than a few inches of cuttings are encountered, the borehole must be recleaned prior to attempting sampling.

5.5 Materials of Construction

The effects of monitoring well construction materials on specific chemical analytical parameters are described and/or referenced in SOP GH-2.8. However, there are several materials used during drilling, particularly drilling fluids and lubricants, which must be used with care to avoid compromising the representativeness of soil and ground water samples.

The use of synthetic or organic polymer slurries is not permitted at any location where soil samples for chemical analysis are to be collected. These slurry materials could be used for installation of long-term monitoring wells, but the early time data in time series collection of ground water data may then be suspect. If synthetic or organic polymer muds are proposed for use at a given site, a complete written justification including methods and procedures for their use must be provided by the site geologist and approved by the Project Manager. The specific slurry composition and the concentration of suspected contaminants for each site must be known.

For many drilling operations, potable water is an adequate lubricant for drill stem and drilling tool connections. However, there are instances, such as drilling in tight clayey formations or in loose gravels, when threaded couplings must be lubricated to avoid binding. In these instances, to be determined in the field by the judgment of the site geologist and noted in the site logbook, and only after approval by the Project Manager, a vegetable oil or silicone-based lubricant should be used. Petroleum based greases, etc. will not be permitted. Samples of lubricants used must be provided and analyzed for chemical parameters appropriate to the given site.

5.6 Subsurface Soil Samples

Subsurface soil samples are used to characterize subsurface stratigraphy. This characterization can indicate the potential for migration of chemical contaminants in the subsurface. In addition, definition of the actual migration of contaminants can be obtained through chemical analysis of the soil samples. Where the remedial activities may include in-situ treatment or excavation and removal of the contaminated soil, the depth and areal extent of contamination must be known as accurately as possible.

Engineering and physical properties of soil may also be of interest should site construction activities be planned. Soil types, grain size distribution, shear strength, compressibility, permeability, plasticity, unit weight, and moisture content are some of the physical characteristics that may be determined for soil samples.

Penetration tests are also described in this procedure. The tests can be used to estimate various physical and engineering parameters such as relative density, unconfined compressive strength, and consolidation characteristics of soils.

Surface protocols for various soil sampling techniques are discussed in SOP SA-1.3. Continuous-core soil sampling and rock coring are discussed below. The procedures described here are representative of

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a larger number of possible drilling and sampling techniques. The choice of techniques is based on a large number of variables such as cost, local geology, etc. The final choice of methods must be made with the assistance of drilling subcontractors familiar with the local geologic conditions. Alternative techniques must be based upon the underlying principles of quality assurance implicit in the following procedures.

The CME continuous sample tube system provides a method of sampling soil continuously during hollow-stem augering. The 5-foot sample barrel fits within the lead auger of a hollow-auger column. The sampling system can be used with a wide range of I.D. hollow-stem augers (from 3-1/4-inch to 8-1/4-inch I.D.). This method has been used to sample many different materials such as glacial drift, hard clays and shales, mine tailings, etc. This method is particularly used when SPT samples are not required and a large volume of material is needed. Also, this method is useful when a visual description of the subsurface lithology is required. Rotosonic drilling methods also provide a continuous soil sample.

5.7 Rock Sampling (Coring) (ASTM D2113-83)

Rock coring enables a detailed assessment of borehole conditions to be made, showing precisely all lithologic changes and characteristics. Because coring is an expensive drilling method, it is commonly used for shallow studies of 500 feet or less, or for specific intervals in the drill hole that require detailed logging and/or analyzing. Rock coring can, however, proceed for thousands of feet continuously, depending on the size of the drill rig, and yields better quality data than air-rotary drilling, although at a substantially reduced drilling rate. Rate of drilling varies widely, depending on the characteristics of lithologies encountered, drilling methods, depth of drilling, and condition of drilling equipment. Average output in a 10-hour day ranges from 40 to over 200 feet. Down hole geophysical logging or television camera monitoring is sometimes used to complement the data generated by coring.

Borehole diameter can be drilled to various sizes, depending on the information needed. Standard sizes of core barrels (showing core diameter) and casing are shown in Figure 1.

Core drilling is used when formations are too hard to be sampled by soil sampling methods and a continuous solid sample is desired. Usually, soil samples are used for overburden, and coring begins in sound bedrock. Casing is set into bedrock before coring begins to prevent loose material from entering the borehole, to prevent loss of drilling fluid, and to prevent cross-contamination of aquifers.

Drilling through bedrock is initiated by using a diamond-tipped core bit threaded to a drill rod (outer core barrel) with a rate of drilling determined by the downward pressure, rotation speed of drill rods, drilling fluid pressure in the borehole, and the characteristics of the rock (mineralogy, cementation, weathering).

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FIGURE 1
STANDARD SIZES OF CORE BARRELS AND CASING

Coring Bit Size	Nor	minal*	Set Size*		
	O.D.	I.D.	O.D.	I.D.	
RWT	1 5/32	3/4	1.160	0.735	
EWT	1 1/2	29/32	1.470	0.905	
EX, EXL, EWG, EWM	1 1/2	13/16	1.470	0.845	
AWT	1 7/8	1 9/32	1.875	1.281	
AX, AXL, AWG, AWM	1 7/8	1 3/16	1.875	1.185	
BWT	2 3/8	1 3/4	2.345	1.750	
BX, BXL, BWG, BWM	2 3/8	1 5/8	2.345	1.655	
NWT	3	2 5/16	2.965	2.313	
NX, NXL, NWG, NWM	3	2 1/8	2.965	2.155	
HWT	3 29/32	3 3/16	3.889	3.187	
HWG	3 29/32	3	3.889	3.000	
2 3/4 x 3 7/8	3 7/8	2 3/4	3.840	2.690	
4 x 5 1/2	5 1/2	4	5.435	3.970	
6 x 7 3/4	7 3/4	6	7.655	5.970	
AX Wire line/	1 7/8	1	1.875	1.000	
BX Wire line/	2 3/8	1 7/16	2.345	1.437	
NX Wire line/	3	1 15/16	2.965	1.937	

^{*} All dimensions are in inches; to convert to millimeters, multiply by 25.4.

___/ Wire line dimensions and designations may vary according to manufacturer.

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FIGURE 1 STANDARD SIZES OF CORE BARRELS AND CASING PAGE TWO

Size Des	ignations			sing pling			,		nate Core neter							
Casing; Casing coupling; Casing bits; Core barrel bits	Rod; rod couplings	Casing O.D., Inches	O.D., Inches	I.D., Inches	Casing bit O.D., Inches	Core barrel bit O.D., Inches*	Drill rod O.D., Inches	Normal, Inches	Thinwall, Inches							
RX	RW	1.437	1.437	1.188	1.485	1.160	1.094		0.735							
EX	Е	1.812	1.812	1.500	1.875	1.470	1.313	0.845	0.905							
AX	Α	2.250	2.250	1.906	2.345	1.875	1.625	1.185	1.281							
ВХ	В	2.875	2.875	2.375	2.965	2.345	1.906	1.655	1.750							
NX	N	3.500	3.500	3.000	3.615	2.965	2.375	2.155	2.313							
HX	HW	4.500	4.500	3.938	4.625	3.890	3.500	3.000	3.187							
RW	RW	1.437			1.485	1.160	1.094		0.735							
EW	EW	1.812	sh Joint	sh Joint		1.875	1.470	1.375	0.845	0.905						
AW	AW	2.250			·	2.345	1.875	1.750	1.185	1.281						
BW	BW	2.875			Flush Joint	sh Joint	sh Joint	sh Joint	sh Joint	<u>+</u>	j g	2.965	2.345	2.125	1.655	1.750
NW	NW	3.500								l jildr	3.615	2.965	2.625	2.155	2.313	
HW	HW	4.500								No Coupling	4.625	3.890	3.500	3.000	3.187	
PW		5.500	🖆	2	5.650											
SW	-	6.625			6.790											
UW		7.625			7.800											
ZW		8.625			8.810											
	AX _\					1.875	1.750	1.000								
	BX _\					2.345	2.250	1.437								
	NX _\					2.965	2.813	1.937								

*	All dimensions are in inches; to convert to millimeters, multiply by 25.4.
/	Wire line dimensions and designations may vary according to manufacturer.

NOMINAL DIMENSIONS FOR DRILL CASINGS AND ACCESSORIES. (DIAMOND CORE DRILL MANUFACTURERS ASSOCIATION). 288-D-2889

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5.7.1 Diamond Core Drilling

A penetration of typically less than 6 inches per 50 blows using a 140-lb. hammer dropping 30 inches with a 2-inch split-barrel sampler shall be considered an indication that soil sampling methods may not be applicable and that coring may be necessary to obtain samples.

When formations are encountered that are too hard to be sampled by soil sampling methods, the following diamond core drilling procedure may be used:

- Firmly seat a casing into the bedrock or the hard material to prevent loose materials from entering the hole and to prevent the loss of drilling fluid return. Level the surface of the rock or hard material when necessary by the use of a fishtail or other bits. If the drill hole can be retained open without the casing and if cross-contamination of aquifers in the unconsolidated materials is unlikely, leveling may be omitted.
- Begin the core drilling using a double-tube swivel-core barrel of the desired size. After drilling no
 more than 10 feet (3 m), remove the core barrel from the hole and take out the core. If the core
 blocks the flow of the drilling fluid during drilling, remove the core barrel immediately. In soft
 materials, a large starting size may be specified for the coring tools; where local experience indicates
 satisfactory core recovery or where hard, sound materials are anticipated, a smaller size or the singletube type may be specified and longer runs may be drilled. NX/NW size coring equipment is the most
 commonly used size.
- When soft materials are encountered that produce less than 50 percent recovery, stop the core
 drilling. If soil samples are desired, secure such samples in accordance with the procedures
 described in ASTM Method D 1586 (Split-barrel Sampling) or in Method D 1587 (Thin-Walled Tube
 Sampling); sample soils per SOP SA-1.3. Resume diamond core drilling when refusal materials are
 again encountered.
- Since rock structures and the occurrence of seams, fissures, cavities, and broken areas are among
 the most important items to be detected and described, take special care to obtain and record these
 features. If such broken zones or cavities prevent further advance of the boring, one of the following
 three steps shall be taken: (1) cement the hole; (2) ream and case; or (3) case and advance with the
 next smaller size core barrel, as conditions warrant.
- In soft, seamy, or otherwise unsound rock, where core recovery may be difficult, M-design core barrels may be used. In hard, sound rock where a high percentage of core recovery is anticipated, the single-tube core barrel may be employed.

5.7.2 Rock Sample Preparation and Documentation

Once the rock coring has been completed and the core recovered, the rock core shall be carefully removed from the barrel, placed in a core tray (previously labeled "top" and "bottom" to avoid confusion), classified, and measured for percentage of recovery as well as the rock quality designation (RQD). Each core shall be described, classified, and logged using a uniform system as presented in SOP GH-1.5. If moisture content will be determined or if it is desirable to prevent drying (e.g., to prevent shrinkage of clay formations) or oxidation of the core, the core shall be wrapped in plastic sleeves immediately after logging. Each plastic sleeve shall be labeled with indelible ink. The boring number, run number, and the footage represented in each sleeve shall be included, as well as designating the top and bottom of the core run.

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After sampling, rock cores shall be placed in the sequence of recovery in well-constructed wooden boxes provided by the drilling contractor. Rock cores from two different borings shall not be placed in the same core box unless accepted by the Project Geologist. The core boxes shall be constructed to accommodate at least 20 linear feet of core in rows of approximately 5 feet each and shall be constructed with hinged tops secured with screws, and a latch (usually a hook and eye) to keep the top securely fastened down. Wood partitions shall be placed at the end of each core run and between rows.

The depth from the surface of the boring to the top and bottom of the drill run and run number shall be marked on the wooden partitions with indelible ink. A wooden partition (wooden block) shall be placed at the end of each run with the depth of the bottom of the run written on the block. These blocks will serve to separate successive core runs and indicate depth intervals for each run. The order of placing cores shall be the same in all core boxes. Rock core shall be placed in the box so that, when the box is open, with the inside of the lid facing the observer, the top of the cored interval contained within the box is in the upper left corner of the box, and the bottom of the cored interval is in the lower right corner of the box. The top and bottom of each core obtained and its true depth shall be clearly and permanently marked on each box. The width of each row must be compatible with the core diameter to prevent lateral movement of the core in the box. Similarly, an empty space in a row shall be filled with an appropriate filler material or spacers to prevent longitudinal movement of the core in the box.

The inside and outside of the core-box lid shall be marked by indelible ink to show all pertinent data on the box's contents. At a minimum, the following information shall be included:

- Project name.
- Project number.
- Boring number.
- Run numbers.
- Footage (depths).
- Recovery.
- RQD (%).
- Box number and total number of boxes for that boring (Example: Box 5 of 7).

For easy retrieval when core boxes are stacked, the sides and ends of the box shall also be labeled and include project number, boring number, top and bottom depths of core and box number.

Prior to final closing of the core box, a photograph of the recovered core and the labeling on the inside cover shall be taken. If moisture content is not critical, the core shall be wetted and wiped clean for the photograph. (This will help to show true colors and bedding features in the cores).

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ATTACHMENT A

DRILLING EQUIPMENT SIZES

Drilling Component	Designation or	O.D.	I.D.	Coupling I.D.
	Hole Size (Inches)	(Inches)	(Inches)	(Inches)
Hollow-stem augers (Ref. 7)	6 1/4	5	2 1/4	
	6 3/4	5 3/4	2 3/4	
	7 1/4	6 1/4	3 1/4	
	13 1/4	12	- 6	
Thin Wall Tube Samplers (Ref. 7)		2	1 7/8	******
		2 1/2	2 3/8	
		3	2 7/8	
		3 1/2	3 3/8	
		4 1/2	4 3/8	
		5	4 3/4	
Drill Rods (Ref. 7)	RW	1 3/32	23/32	13/32
	EW	1 3/8	15/16	7/16
•	AW	1 3/4	1 1/4	5/8
	BW	2 1/8	1 3/4	3/4
	NW	2 5/8	2 1/4	1 3/8
	HW	3 1/2	3 1/16	2 3/8
	E	1 5/16	7/8	7/16
	Α	1 5/8	1 1/8	9/16
	В	1 7/8	1 1/4	5/8
	N	2 3/8	2	1
				Wall Thickness (Inches)
Driven External Coupled Extra Strong Steel* Casing (Ref. 8)	2 1/2	2.875	2.323	0.276
	3	3.5	2.9	0.300
	3 1/2	4.0	3.364	0.318
	4	4.5	3.826	0.337
	5	5.63	4.813	0.375
	6	6.625	5.761	0.432
	8	8.625	7.625	0.500
	10	10.750	9.750	0.500
	12	12.750	11.750	0.500

^{*} Add twice the casing wall thickness to casing O.D. to obtain the approximate O.D. of the external pipe couplings.

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Drilling Component	Designation or Hole Size (Inches)	O.D. (Inches)	I.D. (Inches)	Coupling I.D. (Inches)
Flush Coupled Casing (Ref. 7)	RX	1 7/16	1 3/16	1 3/16
	EX	1 13/16	1 5/8	1 1/2
	AX	2 1/4	2	1 29/32
	BX	2 7/8	2 9/16	2 3/8
	NX	3 1/2	3 3/16	3
	HX	4 1/2	4 1/8	3 15/16
Flush Joint Casing (Ref. 7)	RW	1 7/16	1 3/16	
	EW	1 13/16	1 1/2	
	AW	2 1/4	1 29/32	
	BW	2 7/8	2 3/8	W
	NW	3 1/2	3	
,	HW	4 1/2	4	
	PW	5 1/2	5	
	SW	6 5/8	6	
	UW	7 5/8	7	
	ZW	8 5/8	8	
Diamond Core Barrels (Ref. 7)	EWM	1 1/2	7/8**	
	AWM	1 7/8	1 1/8**	
	BWM	2 3/8	1 5/8**	
	NWM	3	2 1/8	
	HWG	3 7/8	3	
	2 3/4 x 3 7/8	3 7/8	2 11/16	/
	4 x 5 1/2	5 1/2	3 15/16	
	6 x 7 3/4	7 3/4	5 15/16	
	AQ (wireline)	1 57/64	1 1/16**	
	BQ (wireline)	2 23/64	1 7/16**	·
	NQ (wireline)	2 63/64	1 7/8	
	HQ (wireline)	3 25/32	2 1/2	

^{**} Because of the fragile nature of the core and the difficulty to identify rock details, use of small-diameter core (1 3/8") is not recommended.



TETRA TECH NUS, INC.

STANDARD OPERATING PROCEDURES

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Applicability

Tetra Tech NUS, Inc.

Prepared

Earth Sciences Department

Subject

GROUNDWATER MONITORING WELL INSTALLATION

Approved

D. Senovich

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1.0 PURPOSE

This procedure provides general guidance and information pertaining to proper monitoring well design, installation, and development.

2.0 SCOPE

This procedure is applicable to the construction of monitoring wells. The methods described herein may be modified by project-specific requirements for monitoring well construction. In addition, many regulatory agencies have specific regulations pertaining to monitoring well construction and permitting. These requirements must be determined during the project planning phases of the investigation, and any required permits must be obtained before field work begins. Innovative monitoring well installation techniques, which typically are not used, will be discussed only generally in this procedure.

3.0 GLOSSARY

<u>Monitoring Well</u> - A well which is screened, cased, and sealed which is capable of providing a groundwater level and groundwater sample representative of the zone being monitored. Some monitoring wells may be constructed as open boreholes.

<u>Piezometer</u> - A pipe or tube inserted into the water bearing zone, typically open to water flow at the bottom and to the atmosphere at the top, and used to measure water level elevations. Piezometers may range in size from 1/2-inch-diameter plastic tubes to well points or monitoring wells.

<u>Potentiometric Surface</u> - The surface representative of the level to which water will rise in a well cased to the screened aquifer.

Well Point (Drive Point) - A screened or perforated tube (Typically 1-1/4 or 2 inches in diameter) with a solid, conical, hardened point at one end, which is attached to a riser pipe and driven into the ground with a sledge hammer, drop weight, or mechanical vibrator. Well points may be used for groundwater injection and recovery, as piezometers (i.e., to measure water levels) or to provide groundwater samples for water quality data.

4.0 RESPONSIBILITIES

<u>Driller</u> - The driller provides adequate and operable equipment, sufficient quantities of materials, and an experienced and efficient labor force capable of performing all phases of proper monitoring well installation and construction. The driller may also be responsible for obtaining, in advance, any required permits for monitoring well installation and construction.

<u>Field Geologist</u> - The field geologist supervises and documents well installation and construction performed by the driller, and insures that well construction is adequate to provide representative groundwater data from the monitored interval. Geotechnical engineers, field technicians, or other suitable trained personnel may also serve in this capacity.

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5.0 PROCEDURES

5.1 Equipment/Items Needed

Below is a list of items that may be needed when installing a monitoring well or piezometer:

- · Health and safety equipment (hard hats, safety glasses, etc.) as required by the Site Safety Officer.
- Well drilling and installation equipment with associated materials (typically supplied by the driller).
- Hydrogeologic equipment (weighted engineer's tape, water level indicator, retractable engineers rule, electronic calculator, clipboard, mirror and flashlight - for observing downhole activities, paint and ink marker for marking monitoring wells, sample jars, well installation forms, and a field notebook).
- Drive point installation tools (sledge hammer, drop hammer, or mechanical vibrator; tripod, pipe wrenches, drive points, riser pipe, and end caps).

5.2 Well Design

The objectives and intended use for each monitoring well must be clearly defined before the monitoring system is designed. Within the monitoring system, different monitoring wells may serve different purposes and, therefore, require different types of construction. During all phases of the well design, attention must be given to clearly documenting the basis for design decisions, the details of well construction, and the materials used. The objectives for installing the monitoring wells may include:

- Determining groundwater flow directions and velocities.
- · Sampling or monitoring for trace contaminants.
- Determining aquifer characteristics (e.g., hydraulic conductivity).

Siting of monitoring wells shall be performed after a preliminary estimation of the groundwater flow direction. In most cases, groundwater flow directions and potential well locations can be determined by an experienced hydrogeologist through the review of geologic data and the site terrain. In addition, data from production wells or other monitoring wells in the area may be used to determine the groundwater flow direction. If these methods cannot be used, piezometers, which are relatively inexpensive to install, may have to be installed in a preliminary investigative phase to determine groundwater flow direction.

5.2.1 Well Depth, Diameter, and Monitored Interval

The well depth, diameter, and monitored interval must be tailored to the specific monitoring needs of each investigation. Specification of these items generally depends on the purpose of the monitoring system and the characteristics of the hydrogeologic system being monitored. Wells of different depth, diameter, and monitored interval can be employed in the same groundwater monitoring system. For instance, varying the monitored interval in several wells, at the same location (cluster wells) can help to determine the vertical gradient and the depths at which contaminants are present. Conversely, a fully penetrating well is usually not used to quantify or vertically locate a contaminant plume, since groundwater samples collected in wells that are screened over the full thickness of the water-bearing zone will be representative of average conditions across the entire monitored interval. However, fully penetrating wells can be used to establish the existence of contamination in the water-bearing zone. The well diameter desired depends upon the hydraulic characteristics of the water-bearing zone, sampling requirements, drilling method and cost.

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The decision concerning the monitored interval and well depth is based on the following (and possibly other) information:

- The vertical location of the contaminant source in relation to the water-bearing zone.
- The depth, thickness and uniformity of the water-bearing zone.
- The anticipated depth, thickness, and characteristics (e.g., density relative to water) of the contaminant plume.
- Fluctuation in groundwater levels (due to pumping, tidal influences, or natural recharge/discharge events).
- The presence and location of contaminants encountered during drilling.
- Whether the purpose of the installation is for determining existence or non-existence of contamination or if a particular stratigraphic zone is being investigated.
- · The analysis of borehole geophysical logs.

In most situations where groundwater flow lines are horizontal, depending on the purpose of the well and the site conditions, monitored intervals are 20 feet or less. Shorter screen lengths (5 feet or less) are usually required where flow lines are not horizontal, (i.e., if the wells are to be used for accurate measurement of the potentiometric head at a specific point).

Many factors influence the diameter of a monitoring well. The diameter of the monitoring well depends on the application. In determining well diameter, the following needs must be considered:

- Adequate water volume for sampling.
- Drilling methodology.
- · Type of sampling device to be used.
- Costs.

Standard monitoring well diameters are 2, 4, 6, or 8 inches. Drive points are typically 1-1/4 or 2 inches in diameter. For monitoring programs which require screened monitoring wells, either a 2-inch or 4-inch-diameter well is preferred. Typically, well diameters greater than 4 inches are used in monitoring programs in which open-hole bedrock monitoring wells are used. With smaller diameter wells, the volume of stagnant water in the well is minimized, and well construction costs are reduced; however, the sampling devices that can be used are limited.

In specifying well diameter, sampling requirements must be considered (up to a total of 4 gallons of water may be required for a single sample to account for full organic and inorganic analyses, and split samples), particularly if the monitored formation is known to be a low-yielding formation. The unit volume of water contained within a monitoring well is dependent on the well diameter as follows:

Casing Inside Diameter (Inch)	Standing Water Length to Obtain 1 Gallon Water (Feet)
2	6.13
4	1.53
6	0.68

If a well recharges quickly after purging, then well diameter may not be an important factor regarding sample volume requirements.

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Pumping tests for determining aquifer characteristics may require larger diameter wells (for installation of high capacity pumps); however, in small-diameter wells in-situ permeability tests can be performed during drilling or after well installation is completed.

5.2.2 Riser Pipe and Screen Materials

Well materials are specified by diameter, type of material, and thickness of pipe. Well screens require an additional specification of slot size. Thickness of pipe is referred to as "Schedule" for polyvinyl chloride (PVC) casing and is usually Schedule 40 (thinner wall) or 80 (thicker wall). Steel pipe thickness is often referred to as "Strength". Standard Strength is usually adequate for monitoring well purposes. With larger diameter pipe, the wall thickness must be greater to maintain adequate strength. The required thickness is also dependent on the method of installation; risers for drive points require greater strength than wells installed inside drilled borings.

The selection of well screen and riser materials depends on the method of drilling, the type of subsurface materials the well penetrates, the type of contamination expected, and natural water quality and depth. Cost and the level of accuracy required are also important. The materials generally available are Teflon, stainless steel, PVC galvanized steel, and carbon steel. Each has advantages and limitations (see Attachment A of this guideline for an extensive presentation on this topic). The two most commonly used materials are PVC and stainless steel. Properties of these two materials are compared in Attachment B. Stainless steel is a good choice where trace metals or organic sampling is required; however, costs are high. Teflon materials are extremely expensive, but are relatively inert and provide the least opportunity for water contamination due to well materials. PVC has many advantages, including low cost, excellent availability, light weight, ease of manipulation, and widespread acceptance. The crushing strength of PVC may limit the depth of installation, but the use of Schedule 80 materials may overcome some of the problems associated with depth. However, the smaller inside diameter of Schedule 80 pipe may be an important factor when considering the size of bailers or pumps required for sampling or testing. Due to this problem, the minimum well pipe size recommended for Schedule 80 wells is 4-inch I.D.

Screens and risers may have to be decontaminated before use because oil-based preservatives and oil used during thread cutting and screen manufacturing may contaminate samples. Metal pipe may corrode and release metal ions or chemically react with organic constituents, but this is considered a minor issue. Galvanized steel is not recommended where samples may be collected for metals analyses, as zinc and cadmium levels in groundwater samples may become elevated from leaching of the zinc coating.

Threaded, flush-joint casing is most often preferred for monitoring well applications. PVC, Teflon, and steel can all be obtained with threaded joints. Welded-joint steel casing is also acceptable. Glued PVC may release organic contaminants into the well, and therefore, should not be used if the well is to be sampled for organic constituents.

When the water-bearing zone is in consolidated bedrock, such as limestone or fractured granite, a well screen is often not necessary (the well is simply an open hole in bedrock). Unconsolidated materials, such as sands, clay, and silts require a screen. A screen slot size of 0.010 or 0.020 inch is generally used when a screen is necessary, and the annular borehole space around the screened interval is artificially packed with an appropriately sized sand, selected based on formation grain size. The slot size controls the quantity of water entering the well and prevents entry of natural materials or sand pack. The screen shall pass no more than 10 percent of the pack material, or in-situ aquifer material. The site geologist shall specify the combination of screen slot size and sand pack which will be compatible with the water-bearing zone, to maximize groundwater inflow and minimize head losses and movement of fines into the wells. For example, as a standard procedure, a Morie No. 1 or No. 10 to No. 20 U.S. Standard Sieve size filter pack is typically appropriate for a 0.020-inch slot screen; however, a No. 20 to No. 40 U.S. Standard Sieve size filter pack is typically appropriate for a 0.010-inch slot screen.

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5.2.3 Annular Materials

Materials placed in the annular space between the borehole and riser pipe and screen include a sand pack when necessary, a bentonite seal, and cement-bentonite grout. The sand pack is usually a medium-to coarse-grained poorly graded, silica sand and should relate to the grain size of the aquifer sediments. The quantity of sand placed in the annular space is dependent upon the length of the screened interval, but should always extend at least 1 foot above the top of the screen. At least 1 to 3 feet of bentonite pellets or equivalent shall be placed above the sand pack. Cement-bentonite grout (or equivalent) is then placed to extent from the top of the bentonite pellets to the ground surface.

On occasion, and with the concurrence of the involved regulatory agencies, monitoring wells may be packed naturally (i.e., no artificial sand pack installed). In this case, the natural formation material is allowed to collapse around the well screen after the well is installed. This method has been used where the formation material itself is a relatively uniform grain size, or when artificial sand packing is not possible due to borehole collapse.

Bentonite expands by absorbing water and provides a seal between the screened interval and the overlying portion of the annular space and formation. Cement-bentonite grout is placed on top of the bentonite pellets, extending to the surface. The grout effectively seals the remaining borehole annulus and eliminates the possibility for surface infiltration reaching the screened interval. Grouting also replaces material removed during drilling and prevents hole collapse and subsidence around the well. A tremie pipe should be used to introduce grout from the bottom upward, to prevent bridging, and to provide a better seal. In shallow boreholes that don't collapse, it may be more practical to pour the grout from the surface without a tremie pipe.

Grout is a general term which has several different connotations. For all practical purposes within the monitoring well installation industry, grout refers to the solidified material which is installed and occupies the annular space above the bentonite pellet seal. Grout, most of the time, is made up of one or two assemblages of material, (e.g., cement and/or bentonite). A cement-bentonite grout, which is the most common type of grout used in monitoring well completions, normally is a mixture of cement, bentonite, and water at a ratio of one 90-pound bag of Portland Type I cement, plus 3 to 5 pounds of granular or flake-type bentonite, and 6-7 gallons of water. A neat cement consists of one ninety-pound bag of Portland Type I cement and 6-7 gallons of water. A bentonite slurry (bentonite and water mixed to a thick but pumpable mixture) is sometimes used instead of grout for deep well installations where placement of bentonite pellets is difficult. Bentonite chips are also occasionally used for annular backfill in place of grout.

In certain cases, the borehole may be drilled to a depth greater than the anticipated well installation depth. For these cases, the well shall be backfilled to the desired depth with bentonite pellets/chips or sand. A short (1- to 2-foot) section of capped riser pipe sump is sometimes installed immediately below the screen, as a silt reservoir, when significant post-development silting is anticipated. This will ensure that the entire screen surface remains unobstructed.

5.2.4 Protective Casing

When the well is completed and grouted to the surface, a protective steel casing is typically placed over the top of the well. This casing generally has a hinged cap and can be locked to prevent vandalism. The protective casing has a larger diameter than the well and is set into the wet cement grout over the well upon completion. In addition, one hole is drilled just above the cement collar through the protective casing which acts as a weep hole for the flow of water which may enter the annulus during well development, purging, or sampling.

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A protective casing which is level with the ground surface (flush-mounted) is used in roadway or parking lot applications where the top of a monitoring well must be below the pavement. The top of the riser pipe is placed 4 to 5 inches below the pavement, and a locking protective casing is cemented in place to 3 inches below the pavement. A large diameter, manhole-type protective collar is set into the wet cement around the well with the top set level with or slightly above the pavement. An appropriately-sized id is placed over the protective sleeve. The cement should be slightly mounded to direct pooled water away from the well head.

5.3 Monitoring Well Installation

Pertinent data regarding monitoring well installation shall be recorded on log sheets as depicted and discussed in SOP SA-6.3. Attachments to this referenced SOP illustrate terms and physical construction of various types of monitoring wells.

5.3.1 Monitoring Wells in Unconsolidated Sediments

After the borehole is drilled to the desired depth, well installation can begin. The procedure for well installation will partially be dictated by the stability of the formation in which the well is being placed. If the borehole collapses immediately after the drilling tools are withdrawn, then a temporary casing must be installed and well installation will proceed through the center of the temporary casing, and continue as the temporary casing is withdrawn from the borehole. In the case of hollow-stem auger drilling, the augers will act to stabilize the borehole during well installation.

Before the screen and riser pipe are lowered into the borehole, all pipe and screen sections should be measured with an engineer's rule to ensure proper placement. When measuring sections, the threads on one end of the pipe or screen must be excluded while measuring, since the pipe and screen sections are screwed flush together.

After the screen and riser pipe are lowered through the temporary casing, the sand pack can be installed. A weighted tape measure must be used during the installation procedure to carefully monitor installation progress. The sand is slowly poured into the annulus between the riser pipe and temporary casing, as the casing is withdrawn. Sand should always be kept within the temporary casing during withdrawal in order to ensure an adequate sand pack. However, if too much sand is within the temporary casing (greater than 1 foot above the bottom of the casing) bridging between the temporary casing and riser pipe may occur. Centralizers may be used at the geologist's discretion, one above and one below the screen, to assure enough annular space for sand pack placement.

After the sand pack is installed to the desired depth (at least 1 foot above the top of the screen), then the bentonite pellet seal (or equivalent), can be installed in the same manner as the sand pack. At least 1 to 3 feet of bentonite pellets should be installed above the sand pack. Pellets should be added slowly and their fall monitored closely to ensure that bridging does not occur.

The cement-bentonite grout is then mixed and tremied into the annulus as the temporary casing or augers are withdrawn. Finally, the protective casing can be installed as detailed in Section 5.2.4.

5.3.2 Confining Layer Monitoring Wells

When drilling and installing a well in a confined aquifer, proper well installation techniques must be applied to avoid cross contamination between aquifers. Under most conditions, this can be accomplished by installing double-cased wells. This is accomplished by drilling a large-diameter boring through the upper aquifer, 1 to 5 feet into the underlying confining layer, and setting and pressure grouting or tremie grouting a large-diameter casing into the confining layer. The grout material must fill the space between the native material and the outer casing. A smaller diameter boring is then continued through the confining layer for

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installation of the monitoring well as detailed for overburden monitoring wells. Sufficient time (determined by the field geologist), must be allowed for setting of the grout prior to drilling through the confined layer.

5.3.3 Bedrock Monitoring Wells

When installing bedrock monitoring wells, a large diameter boring is drilled through the overburden and approximately 5 –10 feet into bedrock. A casing (typically steel) is installed and either pressure grouted or tremie grouted in place. After the grout has cured, a smaller diameter boring is continued into bedrock to the desired depth. If the boring does not collapse, the well can be left open, and a screen is not necessary. If the boring collapses, then a screen is required and can be installed as detailed for overburden monitoring wells. If a screen is to be used, then the casing which is installed through the overburden and into the bedrock does not require grouting and can be removed when the final well installation is completed.

5.3.4 Drive Points

Drive points can be installed with either a sledge hammer, drop hammer, or a mechanical vibrator. The screen section is threaded and tightened onto the riser pipe with pipe wrenches. The drive point is simply pounded into the subsurface to the desired depth. If a heavy drop hammer is used, then a tripod and pulley setup is required to lift the hammer. Drive points typically cannot be manually driven to depths exceeding 10 feet.

Direct push sampling/monitoring point installation methods, using a direct push rig or drilling rig, are described in SOP SA-2.5.

5.3.5 Innovative Monitoring Well Installation Techniques

Certain innovative sampling devices have proven advantageous. These devices are essentially screened samplers installed in a borehole with only small-diameter tubes extending to the surface. This reduces drilling costs, decreases the volume of stagnant water, and provides a sampling system that minimizes cross-contamination from sampling equipment. Four manufacturers of these samplers include Timco Manufacturing Company, Inc., of Prairie du Sac, Wisconsin, BARCAD Systems, Inc., of Concord, Massachusetts, Westbay Instruments Ltd. of Vancouver, British Columbia, Canada and the University of Waterloo at Waterloo, Ontario, Canada.. Each manufacturer offers various construction materials.

5.4 Well Development Methods

The purpose of well development is to stabilize and increase the permeability of the gravel pack around the well screen, and to restore the permeability of the formation which may have been reduced by drilling operations. Wells are typically developed until all fine material and drilling water is removed from the well. Sequential measurements of pH, conductivity, turbidity, and temperature taken during development may yield information (stabilized values) regarding whether sufficient development has been performed. The selection of the well development method shall be made by the field geologist and is based on the drilling methods, well construction and installation details, and the characteristics of the formation that the well is screened in. The primary methods of well development are summarized below. A more detailed discussion may be found in Driscoll (1986).

5.4.1 Overpumping and Backwashing

Wells may be developed by alternatively drawing the water level down at a high rate (by pumping or bailing) and then reversing the flow direction (backwashing) so that water is passing from the well into the formation. This back and forth movement of water through the well screen and gravel pack serves to

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remove fines from the formation immediately adjacent to the well, while preventing bridging (wedging) of sand grains. Backwashing can be accomplished by several methods, including pouring water into the well and then bailing, starting and stopping a pump intermittently to change water levels, or forcing water into the well under pressure through a water-tight fitting ("rawhiding"). Care should be taken when backwashing not to apply too much pressure, which could damage or destroy the well screen.

5.4.2 Surging with a Surge Plunger

A surge plunger (also called a surge block) is approximately the same diameter as the well casing and is aggressively moved up and down within the well to agitate the water, causing it to move in and out of the screens. This movement of water pulls fine materials into the well, where they may be removed by any of several methods, and prevents bridging of sand particles in the gravel pack. There are two basic types of surge plungers; solid and valved surge plungers. In formations with low yields, a valved surge plunger may be preferred, as solid plungers tend to force water out of the well at a greater rate than it will flow back in. Valved plungers are designed to produce a greater inflow than outflow of water during surging.

5.4.3 Compressed Air

Compressed air can be used to develop a well by either of two methods: backwashing or surging. Backwashing is done by forcing water out through the screens, using increasing air pressure inside a sealed well, then releasing the pressurized air to allow the water to flow back into the well. Care should be taken when using this method so that the water level does not drop below the top of the screen, thus introducing air into the formation and reducing well yield. Surging, or the "open well" method, consists of alternately releasing large volumes of air suddenly into an open well below the water level to produce a strong surge by virtue of the resistance of water head, friction, and inertia. Pumping of the well is subsequently done using the air lift method.

5.4.4 High Velocity Jetting

In the high velocity jetting method, water is forced at high velocities from a plunger-type device and through the well screen to loosen fine particles from the sand pack and surrounding formation. The jetting tool is slowly rotated and raised and lowered along the length of the well screen to develop the entire screened area. Jetting using a hose lowered into the well may also be effective. The fines washed into the screen during this process can then be bailed or pumped from the well.

6.0 RECORDS

A critical part of monitoring well installation is recording of all significant details and events in the site logbook or field notebook. The geologist must record the exact depths of significant hydrogeological features, screen placement, gravel pack placement, and bentonite placement.

A Monitoring Well Sheet (see Attachments to SOP SA-6.3) shall be completed, ensuring the uniform recording of data for each installation and rapid identification of missing information. Well depth, length, materials of construction, length and openings of screen, length and type of riser, and depth and type of all backfill materials shall be recorded. Additional information shall include location, installation date, problems encountered, water levels before and after well installation, cross-reference to the geologic boring log, and methods used during the installation and development process. Documentation is very important to prevent problems involving questionable sample validity. Somewhat different information will need to be recorded, depending on whether the well is completed in overburden (single- or double-cased), as a cased well in bedrock, or as an open hole in bedrock.

The quantities of sand, bentonite, and grout placed in the well are also important. The geologist shall calculate the annular space volume and have an idea of the quantity of material needed to fill the annular

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space. Volumes of backfill significantly higher than the calculated volume may indicate a problem such as a large cavity, while a smaller backfill volume may indicate a cave-in or bridging of the backfill materials. Any problems with rig operation or down-time shall be recorded and may affect the driller's final fee.

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ATTACHMENT A

RELATIVE COMPATIBILITY OF RIGID WELL CASING MATERIAL (PERCENT)

Potentially-Deteriorating Substance	Type of Casing Material								
	PVC 1	Galvanized Steel	Carbon Steel	Lo-carbon Steel	Stainless Steel 304	Stainless Steel 316	Teflon*		
Buffered Weak Acid	100	56	51	59	97	100	100		
Weak Acid	98	59	43	47	96	100	100		
Mineral Acid/ High Solids Content	100	48	57	60	80	82	100		
Aqueous/Organic Mixtures	64	69	73	73	98	100	100		
Percent Overall Rating	91	58	56	59	93	96	100		

Preliminary Ranking of Rigid Materials:

1	Teflon [®]	5	Lo-Carbon Steel
2	Stainless Steel 316	6	Galvanized Steel
3.	Stainless Steel 304	7	Carbon Steel
4	PVC 1		ADDITION BY CAPTURE

^{*} Trademark of DuPont

RELATIVE COMPATIBILITY OF SEMI-RIGID OR ELASTOMERIC MATERIALS (PERCENT)

Potentially- Deteriorating Substance	Type of Casing Material								
	PVC Flexible	PP	PE Conv.	PE Linear	PMM	Viton®*	Silicone	Neoprene	Teflon**
Buffered Weak Acid	97	97	100	97	90	92	87	85	100
Weak Acid	92	90	94	96	78	78	75	75	100
Mineral Acid/ High Solids Content	100	100	100	100	95	100	78	82	100
Aqueous/Organic Mixtures	62	71	40	60	49	78	49	44	100
Percent Overall Rating	88	90	84	88	78	87	72	72	100

Preliminary Ranking of Semi-Rigid or Elastomeric Materials:

1	Teflon [®]	5	PE Conventional
2	Polypropylene (PP)	6	Plexiglas/Lucite (PMM)
3.	PVC Flexible/PE Linear	7	Silicone/Neoprene
4	Viton®		

^{*} Trademark of DuPont

Source: Barcelona et al., 1983

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ATTACHMENT B

COMPARISON OF STAINLESS STEEL AND PVC FOR MONITORING WELL CONSTRUCTION

Characteristic	Stainless Steel	PVC
Strength	Use in deep wells to prevent compression and closing of screen/riser.	Use when shear and compressive strength are not critical.
Weight	Relatively heavier.	Light-weight; floats in water.
Cost	Relatively expensive.	Relatively inexpensive.
Corrosivity Deteriorates more rapidly in corrosive water.		Non-corrosive may deteriorate in presence of ketones, aromatics, alkyl sulfides, or some chlorinated hydrocarbons.
Ease of Use	Difficult to adjust size or length in the field.	Easy to handle and work with in the field.
Preparation for Use	Should be steam cleaned if organics will be subsequently sampled.	Never use glue fittings pipes should be threaded or pressure fitted. Should be steam cleaned when used for monitoring wells.
Interaction with Contaminants*	May sorb organic or inorganic substances when oxidized.	May sorb or release organic substances.

^{*} See also Attachment A.



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Applicability

Tetra Tech NUS, Inc.

Prepared

Earth Sciences Department

Subject

GROUNDWATER SAMPLE ACQUISITION AND ONSITE WATER QUALITY TESTING

Approved

Tom Johnston

TE Johnston

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1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the process to be used for purging groundwater monitoring wells prior to sampling, for collecting groundwater samples, and for measuring groundwater quality parameters.

2.0 SCOPE

This document provides information on proper sampling equipment, onsite water quality testing, safety measures to ensure the safety of the field technician(s), and techniques for groundwater sampling. All personnel are encouraged to review the information contained herein to facilitate planning of the field sampling effort. The techniques described shall be followed whenever applicable, noting that site-specific conditions or project-specific plans may require modifications to methodology.

3.0 GLOSSARY

<u>Conductivity</u> – Conductivity is a numerical expression of the ability of an aqueous solution to carry an electric current. This ability depends on the presence of ions and their total concentration, mobility, valence, and relative concentrations and on temperature. Conductivity is highly dependent on temperature and should be reported at a particular temperature, i.e., 20.2 microSiemens per centimeter (mS/cm) at 14°C.

<u>Dissolved Oxygen (DO)</u> – DO levels in natural and wastewater depend on the physical, chemical, and biochemical activities in the water sample.

<u>Groundwater Sample</u> – A quantity of water removed from the ground, usually via a monitoring well that may or may not be lined with a well casing.

Oxidation-Reduction Potential (ORP) - A measure of the activity ratio of oxidizing and reducing species as determined by the electromotive force developed by a noble metal electrode immersed in water, as referenced against a reference electrode. A reference electrode commonly used in the field is the silver/silver chloride electrode, which has a voltage offset of about 210 mV from the standard hydrogen electrode (SHE). To convert field ORP measurements to equivalent SHE values, approximately 210 mV must be added to the ORP values obtained using the silver/silver chloride electrode. The actual offset depends on the concentration of the potassium chloride (KCI) in the field reference electrode and the temperature. Offsets typically range from 199 (saturated KCI) to 205 (3.5 Molar KCI) to 222 mV (1 Molar KCI) at 25°C and are greater at lower temperatures.

<u>pH</u> - The negative logarithm (base 10) of the hydrogen ion activity. The hydrogen ion activity is related to the hydrogen ion concentration, and, in a relatively weak solution, the two are nearly equal. Thus, for all practical purposes, pH is a measure of the hydrogen ion concentration.

<u>pH Paper</u> - Indicator paper that turns different colors depending on the pH of the solution to which it is exposed. Comparison with color standards supplied by the manufacturer will then give an indication of the solution's pH.

Representativeness – A qualitative description of the degree to which an individual sample accurately reflects population characteristics or parameter variations at a sampling point. It is therefore an important characteristic not only of assessment and quantification of environmental threats posed by the site, but also for providing information for engineering design and construction. Proper sample location selection and proper sample collection methods are important to ensure that a truly representative sample has been collected.

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<u>Salinity</u> – The measurement of dissolved salts in a given mass of solution. Note: most field meters determined salinity automatically from conductivity and temperature. The value will be displayed in either parts per thousand (ppt) or percent (e.g., 35 ppt equals 3.5 percent). The parts per thousand symbol $\binom{0}{100}$ is not the same as the percent symbol $\binom{0}{100}$.

<u>Turbidity</u> – Turbidity in water is caused by suspended matter such as clay, silt, and fine organic and inorganic matter. Turbidity is an expression of the optical property that causes light to be scattered and absorbed rather than transmitted in a straight line through the sample.

4.0 RESPONSIBILITIES AND PERSONNEL QUALIFICATIONS

<u>Project Manager</u> - The Project Manager is responsible for determining the sampling objectives, initial sampling locations, and field procedures used in the collection of groundwater samples. Additionally, in consultation with other project personnel (geologist, hydrogeologist, etc.), the Project Manager identifies sampling locations.

Site Safety Officer (SSO) - The SSO (or a qualified designee) is responsible for providing the technical support necessary to implement the project Health and Safety Plan (HASP). This includes but is not be limited to performing air quality monitoring during sampling, boring and excavation activities, and ensuring that workers and offsite (downwind) individuals are not exposed to hazardous levels of airborne contaminants. The SSO or SSO designee may also be required to advise the FOL on other safety-related matters regarding sampling, such as mitigative measures to address potential hazards from hazardous objects or conditions.

<u>Project Geologist/Sampler</u> - The project geologist/sampler is responsible for the proper acquisition of samples in accordance with this SOP or other project-specific documents. In addition, this individual is responsible for the completion of all required paperwork (e.g., sample log sheets, field notebook, boring logs, container labels, custody seals, and chain-of-custody forms) associated with the collection of those samples.

<u>Project Hydrogeologist</u> – This individual is responsible for selecting and detailing the specific groundwater sampling techniques, onsite water quality testing (type, frequency, and location), equipment to be used, and providing detailed input in this regard to the project planning documents. The project hydrogeologist is also responsible for properly briefing and overseeing the performance of site sampling personnel.

<u>Field Operations Leader (FOL)</u> – This individual is primarily responsible for the execution of the planning document containing the Sampling and Analysis Plan (SAP). This is accomplished through management of a field sampling team for the proper acquisition of samples. He or she is responsible for the supervision of onsite analyses; ensuring proper instrument calibration, care, and maintenance; sample collection and handling; the completion and accuracy of all field documentation; and making sure that custody of all samples obtained is maintained according to proper procedures. When appropriate and as directed by the FOL, such responsibilities may be performed by other qualified personnel (e.g., field technicians) where credentials and time permit. The FOL is ultimately responsible for adherence to Occupational Safety and Health Administration (OSHA) regulations during these operations through self acquisition or through the management of a field team of samplers.

General personnel qualifications for groundwater sample collection and onsite water quality testing include the following:

- Occupational Safety and Health Administration (OSHA) 40-hour and applicable refresher training.
- Capability of performing field work under the expected physical and environmental (i.e., weather)
 conditions.

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Familiarity with appropriate procedures for sample documentation, handling, packaging, and shipping.

5.0 HEALTH AND SAFETY

Specific safety and health precautions are identified throughout this SOP. In addition to those precautions, the following general hazards may be incurred during sampling activities:

- Knee injuries from kneeling on hard surfaces
- Slips, trips, and falls
- Cuts and lacerations
- Traffic hazards associated with sampling in parking areas and roadways and along highways.

Methods of avoiding these hazards are provided below.

Knee injuries – Many monitoring wells are installed as flush mounts. Personnel are required to kneel to open these wells and to take groundwater level measurements, etc. This could result in knee injuries from kneeling on stones/foreign objects and general damage due to stress on the joints. To combat this hazard:

- Clear any foreign objects from the work area.
- Wear hard-sided knee pads.

Slips, Trips, and Falls – These hazards exist while traversing varying terrains carrying equipment to sample wells. To minimize these hazards:

- Pre-survey well locations. Eliminate, barricade, or otherwise mark physical hazards leading to the locations.
- Carry small loads that do not restrict the field of vision.
- Travel the safest and clearest route (not necessarily the shortest).

Cuts and Lacerations – To prevent cuts and lacerations associated with groundwater sampling, the following provisions are required:

- Always cut away from yourself and others when cutting tubing or rope. This will prevent injury to yourself and others if the knife slips.
- Do not place items to be cut in your hand or on your knee.
- Change blades as necessary to maintain a sharp cutting edge. Many accidents result from struggling with dull cutting attachments.
- Whenever practical, wear cut-resistant gloves (e.g., leather or heavy cotton work gloves) at least on the hand not using the knife.
- · Keep cutting surfaces clean and smooth.
- Secure items to be cut -- do not hold them against the opposing hand, a leg, or other body part.

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- When transporting glassware, keep it in a hard-sided container such as a cooler so that if there is a fall, you will be less likely to get cut by broken glass.
- DO NOT throw broken glass or glass ampoules into garbage bags. Place broken glass and glass ampoules in hard-sided containers such as a cardboard box or directly into a dumpster. DO NOT reach into garbage bags to retrieve any item accidentally thrown away. Empty the contents onto a flat surface to avoid punctures and lacerations from reaching where you cannot see.

Vehicular and Foot Traffic Hazards — When sampling along the roadway or near traffic patterns, follow the following precautions:

- Motorists may be distracted by onsite activities ASSUME THEY DO NOT SEE YOU OR MEMBERS
 OF YOUR FIELD CREW.
- DO NOT place obstructions (such as vehicles) along the sides of the road that may cause site
 personnel to move into the flow of traffic to avoid your activities or equipment or that will create a blind
 spot.
- **Provide a required free space of travel**. Maintain at least 6 feet of space between you and moving traffic. Where this is not possible, use flaggers and/or signs to warn oncoming traffic of activities near or within the travel lanes.
- Face Traffic. Whenever feasible, if you must move within the 6 feet of the required free space or into traffic, attempt to face moving traffic at all times. Always leave yourself an escape route.
- Wear high-visibility vests to increase visual recognition by motorists.
- Do not rely on the vehicle operator's visibility, judgment, or ability. Make eye contact with the driver.
 Carefully and deliberately use hand signals so they will not startle or confuse motorists or be mistaken for a flagger's direction before moving into traffic.
- Your movements may startle a motorist and cause an accident, so move deliberately. Do not make sudden movements that might confuse a motorist.

6.0 PROCEDURES

6.1 General

For information derived from a groundwater sample to be useful and accurate, the sample must be representative of the particular zone being sampled. The physical, chemical, and bacteriological integrity of the sample must be maintained from the time of sampling to the time of analysis to keep any changes in water quality parameters to a minimum.

CAUTION

A closed well may generate and accumulate gases due to biological degradation, evolution of volatile chemicals from groundwater into the air, or other chemical actions. These gases may also be artificially generated, such as in the case of air sparging or extraction wells, which may take several days to depressurize. See Section 6.6.2 for safety measures to be employed to protect sampling personnel.

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Methods for withdrawing samples from completed wells include the use of pumps, compressed air or nitrogen, bailers, and various types of samplers. The primary considerations in obtaining a representative sample of groundwater are to avoid collection of stagnant (standing) water in the well and to avoid physical or chemical alteration of the water sample due to external influences of the sampling technique(s). In a non-pumping well, there will be little or no vertical mixing of water in the well pipe or casing, and stratification will occur. The well water in the screened section will mix with groundwater due to normal flow patterns, but the well water above the screened section will remain isolated and become stagnant. Concentration gradients resulting from mixing and dispersion processes, layers of variable geologic permeability, and the presence of separate-phase product (e.g., floating hydrocarbons) may cause stratification. Excessive pumping or improper sampling methods can dilute or increase contaminant concentrations in the collected sample compared to what is representative of the integrated water column as it naturally occurs at that point, resulting in the collection of a non-representative sample. To safeguard against collecting non-representative samples, the following approach shall be followed prior to sample acquisition:

CAUTION

Mechanical agitation of well water may cause off-gas generation of volatile contaminants, creating an inhalation exposure to the sampler(s). Where avoiding an inhalation exposure is not possible and mechanical agitation is possible, pump into closed-top containers to control potential air emissions.

- 1. If possible, position yourself (and the sampling equipment) upwind of the well head.
- 2. Purge the monitoring well to be sampled prior to obtaining any samples from it. Evacuation of three to five well volumes is recommended prior to sampling, unless low-flow purging and sampling methods are utilized as described in Section 6.7 (Consult the site-specific SAP for exact purging parameters). In a high-yielding groundwater formation and where there is no stagnant water in the well above the screened section, extensive evacuation prior to sample withdrawal is not as critical as it is in a low-yielding well or in wells containing stagnant water.
- 3. For wells with low yields that are purged dry during sampling, evacuate the well and allow it to recover to 75 percent of full capacity prior to sample acquisition. If the recovery rate is fairly rapid (generally 300 mL per minute or greater), attempt to continue evacuation until the number of well volumes specified in the SAP is achieved. If this cannot be accomplished, allow recovery to 75 percent of capacity and begin sampling.

CAUTION

For moderate to high-yielding monitoring wells, an evacuation rate that does not cause excessive turbulence in the well should be selected. There is no absolute safeguard against contaminating the sample with stagnant water; hence, special techniques are required for purging to minimize the potential for sample contamination (see below).

- 4. For moderate to high-yielding monitoring wells, use one of the following purge techniques:
 - Place a submersible pump or the intake line of a surface pump or bailer just below the water surface when removing the stagnant water.
 - While purging and as the water level decreases, lower the pump or intake line as the water level
 drops in the well. Three to five volumes of water shall be removed to provide reasonable
 assurance that all stagnant water has been evacuated. After this is accomplished, a bailer or
 other approved device may be used to collect the sample for analysis.

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• Unless otherwise directed, place the intake line of the sampling pump (or the submersible pump itself) near the center of the screened section, and pump approximately one casing volume of water from the well at a low purge rate equal to the well's recovery rate (low-flow sampling).

6.2 <u>Sampling, Monitoring, and Evacuation Equipment</u>

Sample containers shall conform to the guidelines in SOP SA-6.1.

The following equipment shall be on hand when sampling groundwater wells (reference SOPs SA-6.1 and SA-7.1):

 <u>Sample packaging and shipping equipment</u> – Coolers for sample shipping and cooling, chemical preservatives, appropriate sampling containers and filler materials, ice, labels, and chain-of-custody documents.

• Field tools and instrumentation

- Multi-parameter water quality meter with an in-line sample chamber capable of measuring ORP, pH, temperature, DO, specific conductance, turbidity, and salinity, or individual meters (as applicable)
- pH Paper
- Camera and film (if appropriate)
- Appropriate keys (for locked wells)
- Water level indicator and/or oil-water interface probe if separate-phase product is expected

Pumps

- Shallow-well pumps: Centrifugal, bladder, suction, or peristaltic pumps with drop lines and air-lift apparatus (compressor and tubing) where applicable.
- Deep-well pumps: Submersible pump and electrical power-generating unit, or bladder pumps where applicable.
- Other sampling equipment Bailers, graduated cylinder, stopwatch, and inert line with tripod-pulley assembly (if necessary).
- Pails Plastic, graduated.
- Clean paper or cotton towels for cleaning equipment.
- Buckets with lids for collecting purge water.
- <u>Decontamination solutions</u> Deionized water, potable water, phosphate-free laboratory-grade detergent, and analytical-grade solvent (e.g., pesticide-grade isopropanol), as required.

Ideally, sample withdrawal equipment shall be completely inert, economical, easily cleaned, cleaned prior to use, reusable, able to operate at remote sites in the absence of power sources, and capable of delivering variable rates for well purging and sample collection.

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6.3 Calculations of Well Volume

To ensure that the proper volume of water has been removed from the well prior to sampling, it is first necessary to know the volume of standing water in the well pipe (including well screen where applicable). This volume can be easily calculated by the following method. Calculations shall be entered in the site logbook or field notebook or on a sample log sheet form or equivalent electronic form(s) (see SOP SA-6.3):

- 1. Obtain all available information on well construction (location, casing, screen, etc.).
- 2. Determine well or inner casing diameter.
- 3. Measure and record static water level (depth below ground level or top of casing reference point).
- 4. Determine depth of well by sounding using a clean, decontaminated, weighted tape measure or water level indicator.
- 5. Calculate number of linear feet of static water (total depth or length of well pipe minus the depth to static water level).
- 6. Calculate one static well volume in gallons $V = (0.163)(T)(r^2)$

where: V = Static volume of well in gallons.

T = Linear feet of water in the well.

r = Inside radius of well casing in inches.

0.163 = Conversion factor (compensates for conversion of casing radius from inches to feet and cubic feet to gallons and pi.

7. Per evacuation volumes discussed above, determine the minimum amount to be evacuated before sampling.

Measuring devices may become contaminated when gathering the above information if they are submerged in contaminated water. Decontamination of the tape or water level indicator must be conducted between measurements in different wells as follows:

- 1. Saturate a paper towel or clean cotton towel with deionized water.
- 2. As the measuring device is extracted, wipe the tape, changing the cleaning surface frequently.
- 3. After it is extracted, rinse the probe or tape using a spray bottle of deionized water over a bucket or similar collection container.

Based on the contaminant (oily, etc), it may be necessary to use a soap and water wash and rinse to remove contaminants. Isopropanol can be used on the probe/tape. However, it is recommended that the use of solvents on the tape be minimized because they could degrade the protective covering or possibly remove the scale designations. If isopropanol (or some other solvent) is used, assure that the manufacturer/supplier Material Safety Data Sheet (MSDS) is obtained, kept on site at a readily available location with other MSDSs, and reviewed by personnel prior to the first usage of the solvent. Also, add the substance to the site-specific Hazardous Chemical Inventory list (see Section 5 of the TtNUS Health and Safety Guidance Manual [HSGM], Hazard Communication Program and OSHA Standard 29 CFR 1910.1200).

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6.4 <u>Evacuation of Static Water – Purging</u>

6.4.1 General

The amount to be purged from each well will be determined prior to sample collection. This amount will depend on the intent of the monitoring program and the hydrogeologic conditions. Programs to determine overall quality of water resources may require long pumping periods to obtain a sample that is representative of a large volume of the aquifer. The pumped volume may be specified prior to sampling so that the sample can be a composite of a known volume of the aquifer. Alternately, the well can be pumped until parameters such as temperature, specific conductance, pH, and turbidity (as applicable) have stabilized. Onsite measurements of these parameters shall be recorded in the site logbook or field notebook or on standardized data sheets or an equivalent electronic form(s).

6.4.2 Evacuation Devices

The following discussion is limited to those devices commonly used at hazardous waste sites. Attachment A provides guidance on the proper evacuation device to use for given sampling situations. All of these techniques involve equipment that is portable and readily available.

Bailers

Bailers are the simplest evacuation devices used and have many advantages. They generally consist of a length of tubing equipped with a base plate and ball check-valve at the bottom. Bailers are comprised of stainless steel and plastic. They come in a variety of sizes, but the two most often used are 2 inches and 4 inches in diameter. An inert non-absorbent line such as polyethylene rope is used to lower and then raise the bailer to retrieve the sample. As the bailer is lowered into the water column, the ball is pushed up allowing the tube to be filled. When the bailer is pulled upward, the ball seats in the base plate preventing water from escaping.

Advantages of bailers include the following:

- There are few limitations on size and materials used.
- No external power source is needed.
- Bailers are inexpensive and can be dedicated and hung in a well to reduce the chances of crosscontamination.
- Bailers are relatively easy to decontaminate.

Limitations on the use of bailers include the following:

- It is time consuming to remove stagnant water using a bailer.
- Splashing the bailer into the water or transfer of sample may cause aeration.
- The use of a bailer does not permit constant in-line monitoring of groundwater parameters.
- Use of bailers is physically demanding, especially in warm temperatures at personal protection equipment (PPE) levels above Level D.

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Safety concerns using a bailer include the following:

- Muscle stress and strain, especially when using 4-inch bailers and when pulling from excessively deep wells.
- Entanglement, possible hand/finger injuries, and rope burns during a sudden release of the bailer back down the well.
- Direct contact with contaminants of concern and sample preservatives when discharging the bailer contents because there is not a high level of control during a direct pour, and splashing and indirect contact with contaminants/preservatives could occur.

Control measures for these hazards are provided in Section 6.6.2.

Suction Pumps

There are many different types of inexpensive suction pumps including centrifugal, diaphragm, and peristaltic pumps. Centrifugal and diaphragm pumps can be used for well evacuation at a fast pumping rate and for sampling at a low pumping rate. The peristaltic pump is a low-volume pump that uses rollers to squeeze flexible tubing to create suction. This tubing can be dedicated to a well to prevent cross-contamination from well to well. Suction pumps are all portable, inexpensive, and readily available. However, because they are based on suction, their use is restricted to areas with water levels within 20 to 25 feet of the ground surface. A significant limitation is that the vacuum created by these pumps can cause loss of dissolved gases and volatile organics. Another limitation of these pumps is that they require a secondary energy source to drive them. Electrically driven pumps may require portable generators as energy sources. Air diaphragm pumps require air compressors and/or compressed gas cylinders to drive them. The advantage of the peristaltic pump is that it will operate from a portable battery source. Safety measures associated with these pumps are provided below.

Air-Lift and Gas-Lift Samplers

This group of pump samplers uses gas pressure either in the annulus of the well or in a venturi to force groundwater up a sampling tube. These pumps are also relatively inexpensive. Air- or gas-lift samplers are more suitable for well development than for sampling because the samples may be aerated as a result of pump action. Aeration can cause pH changes and subsequent trace metal precipitation or loss of volatile organics.

Submersible Pumps

Submersible pumps take in water and push the sample up a sample tube to the surface. The power sources for these samplers may be compressed gas or electricity. Operation principles vary, and displacement of the sample can be by an inflatable bladder, sliding piston, gas bubble, or impeller. Pumps are available for 2-inch-diameter wells and larger. These pumps can lift water from considerable depths (several hundred feet).

Limitations of this class of pumps include the following:

- They may have low delivery rates.
- Many models are expensive.

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- Compressed gas or electric power is needed.
- Sediment in water may cause clogging of the valves or eroding of the impellers with some of these pumps.
- Decontamination of internal components can be difficult and time consuming.

Compressed Gases

Safety concerns using compressed gases as an energy source in these pumps are numerous. The nitrogen gas or compressed air is provided in a compressed gas cylinder at a pressure of approximately 2,000 psi. If damaged, these cylinders can become dangerous projectiles. Additionally, a sudden release of a cylinder's contents can involve considerable force that could cause significant damage to the eyes and/or skin. Protective measures include the following:

- Always wear safety impact glasses when handling compressed gases.
- Always administer compressed gases through an appropriate pressure-reducing regulator.
- When clearing the cylinder connection port, open the cylinder valve only enough to clear foreign
 debris. During this process, always position the cylinder valve so that it faces away from you and
 others.
- If the cylinder is designed to accept a valve protection cap, always keep that protection cap in place, except the cylinder is connected for use.
- When using the cylinder, lay the cylinder on its side to avoid the potential of it falling and knocking the valve off (and becoming a missile).
- DO NOT use the compressed nitrogen or air to clean clothing or to spray off the skin. Small cuts in the
 protective layer of the skin may permit the gas to enter into the bloodstream, presenting the potential
 danger of an embolism.

See the project-specific HASP for additional direction concerning cylinder safe handling procedures pertaining to the safe handling, transportation, and storage of compressed gas cylinders.

Electrical Shock

Even in situations where portable batteries are used, the potential for electrical shock exists. This potential risk is increased in groundwater sampling activities because of the presence of groundwater near the batteries. This potential is also increased in (prohibited) situations where jury-rigging of electrical connections is performed. Other potential hazards occur when field samplers open the hood of a running car to access the battery as a power source. To control these hazards:

- If you are unfamiliar with electrical devices, do not experiment, get help, and get the proper equipment necessary to power your device.
- Use the proper portable power inverters for cigarette lighter connections to minimize the need to access the battery under the hood of your vehicle.
- Use of electrical generators may pose a number of hazards including noise, those associated with fueling, and indirect sample influence.

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To minimize or eliminate electrical generator hazards:

- Inspect the generator before use. Ensure that the generator and any extension cords are rated for the intended operation and have a Ground Fault Circuit Interrupter (GFCI) in line to control potential electrical shock.
- Fuel the generator before purging and sampling to avoid loss of power during sampling.
- Fuel engines only when they are turned OFF and have cooled sufficiently to prevent a fire hazard.
- Place the generator and any fuel source at least 50 feet from the well to be sampled to avoid indirect influence to the sample from fuel vapors or emission gases.

Lifting Hazards

This hazard may be experienced when moving containers of purge water, equipment, cylinders, etc. To control these potential hazards:

- Do not fill purge buckets to more than 80 percent of their capacity.
- Obtain a gas cylinder of sufficient size to complete the designated task but not too large to handle. Ksize cylinders weigh approximately 135 pounds and are difficult to handle. M-size cylinders weigh approximately 50 pounds and are easier to handle and move.
- When necessary, get help lifting and moving gas cylinders and other heavy objects. Minimize twisting
 and turning while lifting. If it is necessary to move these cylinders or generators over significant
 distance, use mechanical means (carts, etc.).
- Use proper lifting techniques as described in Section 4.4 of the HSGM.

6.5 Onsite Water Quality Testing

This section describes the procedures and equipment required to measure the following parameters of an aqueous sample in the field:

- nH
- Specific conductance
- Temperature
- DO
- ORP
- Turbidity
- Salinity

This section is applicable for use in an onsite groundwater quality monitoring program to be conducted at a hazardous or nonhazardous waste site. The procedures and equipment described are applicable to groundwater samples and are not, in general, subject to solution interferences from color, turbidity, or colloidal material or other suspended matter.

This section provides general information for measuring the parameters listed above with instruments and techniques in common use. Because instruments from different manufacturers may vary, review of the manufacturer's literature pertaining to the use of a specific instrument is required before use. Most meters

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used to measure field parameters require calibration on a daily basis. Refer to SOP SA-6.3 for an example equipment calibration log.

6.5.1 Measurement of pH

6.5.1.1 General

Measurement of pH is one of the most important and frequently used tests in water chemistry. Practically every phase of water supply and wastewater treatment such as acid-base neutralization, water softening, and corrosion control is pH dependent. Likewise, the pH of leachate can be correlated with other chemical analyses to determine the probable source of contamination. It is therefore important that reasonably accurate pH measurements be taken and recorded on the groundwater sample log sheet (Attachment B) or equivalent electronic form.

Two methods are given for pH measurement: the pH meter and pH indicator paper. Indicator paper is used when only an approximation of the pH is required or when pH meter readings need to be verified, and the pH meter is used when a more accurate measurement is needed. The response of a pH meter can be affected by high levels of colloidal or suspended solids, but the effect is generally of little significance. Consequently, specific methods to overcome this interference are not described. The response of pH paper is unaffected by solution interferences from color, turbidity, or colloidal or suspended materials unless extremely high levels capable of coating or masking the paper are encountered. In such cases, use of a pH meter is recommended.

6.5.1.2 Principles of Equipment Operation

Use of pH papers for pH measurement relies on a chemical reaction caused by the acidity or alkalinity of the solution created by the addition of the water sample reacting with the indicator compound on the paper. Various types of pH papers are available, including litmus (for general acidity or alkalinity determination) and specific, or narrower range, pH range paper.

Use of a pH meter relies on the same principle as other ion-specific electrodes. Measurement relies on establishment of a potential difference across a glass or other type of membrane in response to (in this instance, hydrogen) ion activity (which is usually similar to concentration) across that membrane. The membrane is conductive to ionic species and, in combination with a standard or reference electrode, a potential difference proportional to the ion concentration is generated and measured.

6.5.1.3 Equipment

The following equipment is to be used for obtaining pH measurements:

- A stand-alone portable pH meter or combination meter equipped with an in-line sample chamber (e.g., YSI 600 series and Horiba U-22).
- Combination electrode with polymer body to fit the above meter. Alternately, a pH electrode and a reference electrode can be used if the pH meter is equipped with suitable electrode inputs.
- Buffer solutions, as specified by the manufacturer. If the buffer solutions are considered hazardous per 29 Code of Federal Regulations (CFR) 1910.1200 (Hazard Communication) or the volumes used are greater than consumer commodity levels, the SSO shall obtain MSDSs from the manufacturer for the specific buffer solutions (see Section 4 of the HSGM regarding the Hazard Communication Program)

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- pH indicator paper to cover the pH range 2 through 12.
- Manufacturer's operation manual. All personnel must be familiar with the equipment operation to
 ensure that the integrity of samples is preserved and that the equipment is operated safely.

6.5.1.4 Measurement Techniques for Field Determination of pH

pH Meter

The following procedure shall be used for measuring pH with a pH meter (meter standardization is according to manufacturer's instructions):

- 1. Inspect the instrument and batteries prior to initiation of the field effort.
- 2. Check the integrity of the buffer solutions used for field calibration. Buffer solutions need to be changed often as a result of degradation upon exposure to the atmosphere.
- 3. If applicable, make sure all electrolyte solutions within the electrode(s) are at their proper levels and that no air bubbles are present within the electrode(s).
- 4. Calibrate the meter and electrode(s) on a daily use basis (or as recommended by manufacturer) following manufacturer's instructions. Record calibration data on a water quality meter calibration log sheet (Attachment C) or equivalent electronic form.
- 5. Immerse the electrode(s) in the sample. Stabilization may take several seconds to minutes. If the pH continues to drift, the sample temperature may not be stable, a physical reaction (e.g., degassing) may be taking place in the sample, or the meter or electrode may be malfunctioning. The failure of the measurements to stabilize must be clearly noted in the logbook or equivalent electronic form.
- 6. Read and record the pH of the sample. pH shall be recorded to the nearest 0.01 pH standard unit. Also record the sample temperature (unless otherwise specified in the SAP, record temperatures to the nearest whole degree Fahrenheit or 0.5 degree Celsius).
- 7. Rinse the electrode(s) with deionized water.
- 8. Store the electrode(s) in an accordance with manufacturer's instructions when not in use.

Any visual observation of conditions that may interfere with pH measurement, such as oily materials or turbidity, shall be noted and avoided as much as possible.

pH Paper

Use of pH paper is very simple and requires no sample preparation, standardization, etc. pH paper is available in several ranges, including wide-range (indicating approximately pH 1 to 12), mid-range (approximately pH 0 to 6, 6 to 9, 8 to 14) and narrow-range (many available, with ranges as narrow as 1.5 pH units). The appropriate range of pH paper shall be selected. If the pH is unknown the investigation shall start with wide-range paper and proceed with successively narrower range paper until the sample pH is determined. To measure the pH with pH paper:

1. Collect a small portion of sample into a clean container.

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- 2. Dip the pH paper into this small portion of sample.
- 3. Compare the color of the paper to the color chart that is provided with the pH paper and read the corresponding pH from the chart.
- 4. Record the pH value from the chart on the sampling log sheet.
- 5. Discard the used pH paper as trash.
- 6. Discard the small volume of sample that was used for the pH measurement with the other investigative derived waste.

6.5.2 Measurement of Specific Conductance

6.5.2.1 General

Conductance provides a measure of dissolved ionic species in water and can be used to identify the direction and extent of migration of contaminants in groundwater or surface water. It can also be used as a measure of subsurface biodegradation or to indicate alternate sources of groundwater contamination.

Conductivity is a numerical expression of the ability of a water sample to carry an electric current. This value depends on the total concentration of ionized substances dissolved in the water and the temperature at which the measurement is made. The mobility of each of the various dissolved ions, their valences, and their actual and relative concentrations affect conductivity.

It is important to obtain a specific conductance measurement soon after taking a sample because temperature changes, precipitation reactions, and absorption of carbon dioxide from the air all affect specific conductance. Most conductivity meters in use today display specific conductance in units of mS/cm, which is the conductivity normalized to a temperature of 25°C. These are the required units to be recorded on the groundwater sample log field form or equivalent electronic form.

6.5.2.2 Principles of Equipment Operation

An aqueous system containing ions will conduct an electric current. In a direct-current field, the positive ions migrate toward the negative electrode, and the negatively charged ions migrate toward the positive electrode. Most inorganic acids, bases, and salts such as hydrochloric acid, sodium carbonate, and sodium chloride, respectively, are relatively good conductors. Conversely, organic compounds such as sucrose or benzene, which do not dissociate in aqueous solution, conduct a current very poorly if at all.

A conductance cell and a Wheatstone Bridge (for the measurement of potential difference) may be used for measurement of electrical resistance. The ratio of current applied to voltage across the cell may also be used as a measure of conductance. The core element of the apparatus is the conductivity cell containing the solution of interest. Depending on the ionic strength of the aqueous solution to be tested, a potential difference is developed across the cell, which can be converted directly or indirectly (depending on instrument type) to a measurement of specific conductance.

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6.5.2.3 Equipment

The following equipment is needed for taking specific conductance measurements:

- Stand-alone portable conductivity meter or combination meter equipped with an in-line sample chamber (e.g., YSI 600 series and Horiba U-22).
- Calibration solution, as specified by the manufacturer.
- Manufacturer's operation manual.

A variety of conductivity meters are available that may also be used to monitor salinity and temperature. Probe types and cable lengths vary, so equipment must be obtained to meet the specific requirements of the sampling program.

6.5.2.4 Measurement Techniques for Specific Conductance

The steps involved in taking specific conductance measurements are as follows (calibration shall be conducted according to manufacturer's instructions):

- 1. Check batteries and calibrate instrument before going into the field.
- 2. Calibrate on a daily use basis (or as recommended by manufacturer), according to the manufacturer's instructions and record all pertinent information on a water quality meter calibration log sheet or equivalent electronic form. Potassium chloride solutions with a specific conductance closest to the values expected in the field shall be used for calibration.
- 3. Rinse the cell with one or more portions of the sample to be tested or with deionized water and shake excess water from the cell.
- 4. Immerse the electrode in the sample and measure the conductivity.
- 5. Read and record the results in a field logbook or on a sample log sheet or equivalent electronic form.
- 6. Rinse the electrode with deionized water.

If the specific conductance measurements become erratic, recalibrate the instrument and see the manufacturer's instructions for troubleshooting assistance.

6.5.3 Measurement of Temperature

6.5.3.1 General

In combination with other parameters, temperature can be a useful indicator of the likelihood of biological action in a water sample. It can also be used to trace the flow direction of contaminated groundwater. Temperature measurements shall be taken in situ, or as quickly as possible in the field because collected water samples may rapidly equilibrate with the temperature of their surroundings.

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6.5.3.2 Equipment

Temperature measurements may be taken with alcohol-toluene, mercury-filled, dial-type thermometers or combination meters equipped with an in-line sample chamber (e.g., YSI 600 series and Horiba U-22). In addition, various meters such as specific conductance or DO meters that have temperature measurement capabilities may also be used. Using such instrumentation along with suitable probes and cables, in-situ measurements of temperature at great depths can be performed.

6.5.3.3 Measurement Techniques for Water Temperature

If a thermometer is used to determine the temperature for a water sample, use the following procedure:

- 1. Immerse the thermometer in the sample until temperature equilibrium is obtained (1 to 3 minutes). To avoid the possibility of cross-contamination, the thermometer shall not be inserted into samples that will undergo subsequent chemical analysis.
- 2. Record values in a field logbook or on a sample log sheet or equivalent electronic form.

If a temperature meter or probe is used:

- 1. Calibrate the instrument according to manufacturer's recommendations prior to use.
- 2. Immerse the meter/probe in the sample until temperature equilibrium is obtained (1 to 3 minutes). To avoid the possibility of cross-contamination, the meter/probe shall not be inserted into samples that will undergo subsequent chemical analysis.
- 3. Record values in a field logbook or on a sample log sheet or equivalent electronic form.

6.5.4 Measurement of Dissolved Oxygen

6.5.4.1 General

DO levels in natural water and wastewater depend on the physical, chemical and biochemical activities in the water body. In addition, the growth of many aquatic organisms and the rate of corrosivity are dependent on DO concentrations. Thus, analysis for DO is a key test in water pollution and waste treatment process control. If at all possible, DO measurements shall be taken in situ because concentrations may show a large change in a short time if the sample is not adequately preserved.

The monitoring method discussed herein is limited to the use of DO meters. Chemical methods of analysis (i.e., Winkler methods) are available but require more equipment and greater sample manipulation. Furthermore, DO meters using a membrane electrode are suitable for highly polluted waters because the probe is completely submersible and is not susceptible to interference caused by color, turbidity, or colloidal material or suspended matter.

6.5.4.2 Principles of Equipment Operation

DO probes are normally electrochemical cells that have two solid metal electrodes of different nobility immersed in an electrolyte. The electrolyte is retained by an oxygen-permeable membrane. The metal of highest nobility (the cathode) is positioned at the membrane. When a suitable potential exists between

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the two metals, reduction of oxygen to hydroxide ion (OH-) occurs at the cathode surface. An electrical current is developed that is directly proportional to the rate of arrival of oxygen molecules at the cathode. This rate is proportional to the oxygen concentration in the water being measured.

Because the current produced in the probe is directly proportional to the rate of arrival of oxygen at the cathode, it is important that a fresh supply of sample always be in contact with the membrane. Otherwise, the oxygen in the aqueous layer along the membrane is quickly depleted and false low readings are obtained. It is therefore necessary to stir the sample (or the probe) constantly to maintain fresh solution near the membrane interface. Stirring, however, shall not be so vigorous that additional oxygen is introduced through the air-water interface at the sample surface. To avoid this possibility, some probes are equipped with stirrers to agitate the solution near the probe, leaving the surface of the solution undisturbed.

DO probes are relatively unaffected by interferences. Interferences that can occur are reactions with oxidizing gases such as chlorine or with gases such as hydrogen sulfide that are not easily depolarized from the indicating electrode. If a gaseous interference is suspected, it shall be noted in the field logbook and checked if possible. Temperature variations can also cause interference because probes exhibit temperature sensitivity. Automatic temperature compensation is normally provided by the manufacturer. This compensation can counteract some of the temperature effects but not all of them.

6.5.4.3 Equipment

The following equipment is needed to measure DO concentrations:

- A stand-alone portable DO meter or combination meter equipped with an in-line sample chamber (e.g., YSI 600 series and Horiba U-22).
- Sufficient cable to allow the probe to contact the sample.
- Manufacturer's operation manual.

6.5.4.4 Measurement Techniques for Dissolved Oxygen Determination

DO probes differ as to instructions for use. Follow the manufacturer's instructions to obtain an accurate reading. The following general steps shall be used to measure DO concentrations:

- 1. Check the DO meter batteries before going to the field.
- 2. Condition the probe in a water sample for as long a period as practical before use in the field. Long periods of dry storage followed by short periods of use in the field may result in inaccurate readings.
- Calibrate the instrument in the field according to manufacturer's recommendations or in a freshly airsaturated water sample of known temperature.
- Record all pertinent information on a water quality meter calibration log sheet or equivalent electronic form.
- 5. Rinse the probe with deionized water.
- 6. Immerse the probe in the sample. Be sure to provide for sufficient flow past the membrane by stirring the sample. Probes without stirrers placed in wells may be moved up and down to achieve the required mixing.

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- 7. Record the DO content and temperature of the sample in a field logbook or on a sample log sheet or equivalent electronic form.
- 8. Rinse the probe with deionized water.
- 9. Recalibrate the probe when the membrane is replaced, or as needed. Follow the manufacturer's instructions.

Note that in-situ placement of the probe is preferable because sample handling is not involved. This however may not always be practical.

Special care shall be taken during sample collection to avoid turbulence that can lead to increased oxygen solubilization and positive test interferences.

6.5.5 Measurement of Oxidation-Reduction Potential

6.5.5.1 General

ORP provides a measure of the tendency of organic or inorganic chemicals to exist in an oxidized state. The ORP parameter therefore provides evidence of the likelihood of anaerobic degradation of biodegradable organics or the ratio of activities of reduced to oxidized species in the sample.

6.5.5.2 Principles of Equipment Operation

When an inert metal electrode, such as platinum, is immersed in a solution, a potential is developed at that electrode depending on the ions present in the solution. If a reference electrode is placed in the same solution, an ORP electrode pair is established. This electrode pair allows the potential difference between the two electrodes to be measured and is dependent on the concentration of the ions in solution. By this measurement, the ability to oxidize or reduce species in solution may be determined. Supplemental measurements, such as DO, may be correlated with ORP to provide knowledge of the quality of the solution, water, or wastewater.

6.5.5.3 Equipment

The following equipment is needed for measuring the ORP of a solution:

- A combination meter with an in-line sample chamber (e.g., YSI 600 series and Horiba U-22).
- Reference solution as specified by the manufacturer.
- Manufacturer's operation manual.

6.5.5.4 Measurement Techniques for Oxidation-Reduction Potential

The following procedure is used for measuring ORP:

1. Check the equipment using the manufacturer's recommended reference solution and check its batteries before going to the field.

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- 2. Thoroughly rinse the electrode with deionized water.
- 3. If the probe does not respond properly to the recommended reference solution, verify the sensitivity of the electrodes by noting the change in millivolts when the pH of a test solution is altered. The ORP will increase when the pH of a test solution decreases, and the ORP will decrease when the test solution pH is increased. Place the sample in a clean container and agitate the sample. Insert the electrodes and note that the ORP drops sharply when the caustic is added (i.e., pH increases) thus indicating that the electrodes are sensitive and operating properly. If the ORP increases sharply when the caustic is added, the polarity is reversed and must be corrected in accordance with the manufacturer's instructions or the probe should be replaced.
- 4. Record all pertinent information on a water quality meter calibration log sheet or equivalent electronic form.

6.5.6 Measurement of Salinity

6.5.6.1 General

Salinity is a unitless property of industrial and natural waters. It is the measurement of dissolved salts in a given mass of solution. Most field meters determine salinity automatically from conductivity and temperature. The displayed value will be displayed in either parts per thousand (ppt) or percent (e.g., 35 ppt equals 3.5 percent).

6.5.6.2 Principles of Equipment Operation

Salinity is determined automatically from the meter's conductivity and temperature readings according to algorithms (such as are found in Standard Methods for the Examination of Water and Wastewater). Depending on the meter, the results are displayed in either ppt or percent. The salinity measurements are carried out in reference to the conductivity of standard seawater (corrected to salinity = 35 ppt).

6.5.6.3 Equipment

The following equipment is needed for salinity measurements:

- A multi-parameter water quality meter capable of measuring conductivity and temperature and converting them to salinity (e.g., Horiba U-22 or YSI 600 series).
- Calibration solution as specified by the manufacturer.
- Manufacturer's operation manual.

6.5.6.4 Measurement Techniques for Salinity

The steps involved in taking salinity measurements are as follows (standardization shall be conducted according to manufacturer's instructions):

- 1. Check the expiration date of the solutions used for field calibration and replace them if they are expired.
- 2. Check batteries and calibrate the meter before going into the field.

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- 3. Calibrate on a daily use basis, according to the manufacturer's instructions and record all pertinent information on a water quality meter calibration log sheet or equivalent electronic form.
- 4. Rinse the cell with the sample to be tested. This is typically accomplished as the probe is placed in line during the collection of the purge water up to the time of sample acquisition.
- 5. Immerse the multi-probe in the sample and measure the salinity. Read and record the results in a field logbook or on a sample log sheet or equivalent electronic form.
- 6. Rinse the probes with deionized water.

6.5.7 Measurement of Turbidity

6.5.7.1 General

Turbidity is an expression of the optical property that causes light to be scattered and absorbed rather than transmitted in a straight line through the sample. Turbidity in water is caused by suspended matter such as clay, silt, or other finely divided organic and inorganic matter and microscopic organisms including plankton.

It is important to obtain a turbidity reading immediately after taking a sample because irreversible changes in turbidity may occur if the sample is stored too long.

6.5.7.2 Principles of Equipment Operation

Turbidity is measured by the Nephelometric Method, which is based on a comparison of the intensity of light scattered by the sample under defined conditions with the intensity of light scattered by a standard reference suspension under the same conditions. The higher the scattered light intensity, the higher the turbidity.

Formazin polymer is used as the reference turbidity standard suspension because of its ease of preparation combined with a higher reproducibility of its light-scattering properties than clay or turbid natural water. The turbidity of a specified concentration of formazin suspension is defined as 40 nephelometric units. This same suspension has an approximate turbidity of 40 Jackson units when measured on the candle turbidimeter. Therefore, nephelometric turbidity units (NTUs) based on the formazin preparation will approximate units derived from the candle turbidimeter but will not be identical to them.

6.5.7.3 Equipment

The following equipment is needed for turbidity measurements:

- A turbidity meter (e.g., LaMotte 2020) that calibrates easily using test cells with standards of 0.0, 1.0, and 10 NTUs, or a combination meter equipped with an in-line sample chamber (e.g., YSI 600 series and Horiba U-22).
- Calibration solution and sample tubes, as specified by the manufacturer.
- Manufacturer's operation manual.

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6.5.7.4 Measurement Techniques for Turbidity

The steps involved in taking turbidity measurements utilizing an electrode (e) or light meter (l) are listed below (standardization shall be done according to manufacturer's instructions):

- 1. Check the expiration date of the solutions used for field calibration and replace them if they are expired.
- 2. Check batteries and calibrate the instrument before going into the field.
- 3. Calibrate on a daily basis according to the manufacturer's instructions, and record all pertinent information on a turbidity meter calibration log sheet (Attachment C) or equivalent electronic form.
- 4. When using the YSI and/or Horiba U-22, rinse the electrode with one or more portions of the sample to be tested or with deionized water.
- 5. When using the Lamotte 2020, fill the light meter's glass test cell with approximately 5 mL of sample, screw on the cap, wipe off glass to remove all residue that could intercept the instrument's light beam, place the test cell in the light meter, and close the lid.
- 6. Immerse the electrode in the sample and measure the turbidity.
- 7. The reading must be taken immediately because suspended solids will settle over time resulting in a lower, inaccurate turbidity reading.
- 8. Read and record the results in a field logbook or on a sample log sheet or equivalent electronic form. Include a physical description of the sample, including color, qualitative estimate of turbidity, etc.
- 9. Rinse the electrode or test cell with deionized water.

6.6 Sampling

6.6.1 Sampling Plan

The sampling approach consisting of the following shall be developed as part of the project planning documents approved prior to beginning work in the field:

- Background and objectives of sampling.
- Brief description of area and waste characterization.
- Identification of sampling locations, with map or sketch, and applicable well construction data (well size, depth, screened interval, reference elevation).
- Intended number, sequence, volumes, and types of samples. If the relative degree of contamination between wells is insignificant, a sampling sequence that facilitates sampling logistics may be followed. Where some wells are known or strongly suspected of being highly contaminated, these shall be sampled last to reduce the risk of cross-contamination between wells. In situations where the well is not well-characterized and the nature or extent of airborne contamination is unknown, it is recommended that head space analysis using a photoionization detector (PID) or flame ionization detector (FID) is performed to rate the wells, sampling from least contaminated to most contaminated.

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Refer to the project-specific HASP for appropriate information and direction on air monitoring requirements.

- Sample preservation requirements.
- Work schedule.
- List of team members.
- List of observers and contacts.
- Other information, such as the necessity for a warrant or permission of entry, requirements for split samples, access problems, location of keys, etc.
- The FOL shall ensure that the sampling method(s) to be employed is accurately represented in the HASP, indicating the types of sampling to be employed and the hazards. If the methods are not accurately represented, the FOL should rectify this with the HASP author.
- The FOL shall ensure that sampling teams understand the sampling approach that they are to follow. Where sampling teams are made up of personnel from multiple locations, personal sampling experiences may vary. Therefore the FOL shall review project-specific requirements, SOPs, and protocol to be followed. The FOL will conduct periodic surveys to ensure that these methods are being completed per his/her direction.

6.6.2 Sampling Methods as Related to Low-Flow Sampling

The collection of a groundwater sample consists of the following steps:

- 1. Ensure the safety of the sample location. Take a few minutes to evaluate the area for physical hazards (trip hazards, uneven ground, overhanging branches, etc.) and natural hazards (snakes, bees, spiders, etc.) that may exist in the area or that may have constructed nests in the well head. Snakes often like to sun themselves on concrete well pads. Follow provisions in the project-specific HASP and/or HSGM for addressing natural hazards.
- 2. As indicated earlier, some monitoring wells have the potential to contain pressurized headspace (e.g., through the generation of gases form contaminated groundwater, due to biological processes, degradation of contaminants, or simply based on location such as near a landfill or in areas that intersect lithological abnormalities) or through intentional artificial means such as those associated with air sparging systems. Injection or extraction wells may be artificially pressurized and may remain so for several days after the system has been turned off. This presents a hazard to people opening these wells. The Field Sampling Technician shall employ the following practices to minimize these hazards:
 - Wear safety glasses to protect the eyes. If site-specific observations and conditions indicate that the wells may be pressurized, wear a full-face shield over the safety impact eye protection.
 - DO NOT place your face or any other part of your body over the well when opening because this
 may place you in a strike zone.
 - Open the well cover at arms length, then step away and allow the well to off gas and stabilize.

Follow directions provided in the project-specific HASP, Work Plan and/or Sampling Plan pertaining to the use of volatile chemical detection equipment (PID or FID) within the breathing zone of the sampler

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during sampling to determine the need to retreat from the work area and/or for the use of respiratory protection (as specified in the HASP).

- 3. When proper respiratory protection has been donned, sound the well for total depth and water level (using clean equipment) and record these data on a groundwater sampling log sheet or equivalent electronic form; then calculate the fluid volume in the well pipe (as previously described in this SOP). It is imperative that downhole equipment be adequately decontaminated between wells to prevent cross-contamination. Just as sampling occurs from the least contaminated to the most contaminated, it is also recommended that groundwater level measurements be taken in this manner.
- 4. Calculate volume of well water to be removed as described in Section 6.3.
- 5. Select the appropriate purging equipment (see Attachment A to this SOP) or as designated within your Work Plan/Sampling Plan. If an electric submersible pump with packer is chosen, go to Step 10.
- 6. Lower the purging equipment or intake into the well to a short distance below the water level or midscreen as indicated in project-specific documentation and begin water removal. Remember that some contaminants are "bottom dwellers," and in these cases, project-specific direction may specify placing the intake just above (1 to 2 feet) the well bottom. Secure the pump intake at the well and secure the effluent at the collection container and begin pumping. The pumping rate will be determined based on the decrease in the water level (see Section 6.7) or as directed in your project-specific documents or this SOP. Purge water is generally collected in a 5-gallon bucket or similar open- or closed-top container. To minimize the potential for spills and back injuries, do not fill 5-gallon buckets beyond approximately 80 percent of their capacity. Dispose of purge water was as indicated in the planning document(s). Where necessary, slow the pumping rate or lower the pump intake as required to maintain submergence.
- 7. Estimate the approximate rate of discharge frequently and record it on the Low Flow Purge Data Sheet (see Attachment D). Estimate flow rate by noting the amount of discharge in a bucket or graduated cylinder per unit time using a watch with a second hand or a stopwatch.
- 8. Observe the peristaltic pump tubing intake for degassing "bubbles." If bubbles are abundant and the intake is fully submerged, this pump is not suitable for collecting samples for volatile organics.
- 9. Purge a minimum of three to five casing volumes before sampling (or as directed by the site-specific SAP). In low-permeability strata (i.e., if the well is pumped to dryness), one volume will suffice. Allow the well to recover to 75 percent of initial water level before sampling. Do not overfill purge containers because this increases the potential for spills and lifting injuries.
- 10. If sampling using a submersible pump, lower the pump intake to mid-screen (or the middle of the open section in uncased wells) and collect the sample. If sampling with a bailer, lower the bailer to just below the water surface.
- 11. For pump and packer assemblies only: Lower the assembly into the well so that the packer is positioned just above the screen or open section. Inflate the packer. Purge a volume equal to at least twice the screened interval (or unscreened open section volume below the packer) before sampling. Packers shall always be tested in a casing section above ground to determine proper inflation pressures for good sealing.
- 12. If the recovery time of the well is very slow (e.g., 24 hours or greater), sample collection can be delayed until the following day. If the well has been purged early in the morning, sufficient water may be standing in the well by the day's end to permit sample collection. If the well is incapable of producing a sufficient volume of sample at any time, take the largest quantity available and record this

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occurrence in the site logbook or equivalent electronic form. When this occurs, contact the analytical laboratory to alert them that a reduced sample volume(s) will be submitted for analysis.

- 13. Fill sample containers and preserve and label them as described in SOP SA-6.1. Many sample bottles will contain preservative when they are shipped to the field. In those cases, do not add preservative.
- 14. Replace the well cap and lock it as appropriate. Make sure the well is readily identifiable as the source of the sample.
- 15. Process sample containers as described in SOP SA-6.1.
- 16. Decontaminate equipment as described in SOP SA-7.1.

6.7 Low-Flow Purging and Sampling

6.7.1 Scope and Application

Low-flow purging and sampling techniques may be required for groundwater sampling activities. The purpose of low-flow purging and sampling is to collect groundwater samples that contain "representative" amounts of mobile organic and inorganic constituents in the vicinity of the selected open well interval, at or near natural flow conditions. This minimum-stress procedure emphasizes negligible water level drawdown and low pumping rates to collect samples with minimal alterations in water chemistry. This procedure is designed primarily to be used in wells with a casing diameter of 1 inch or more and a saturated screen length, or open interval, of 10 feet or less. Samples obtained are suitable for analyses of common types of groundwater contaminants (volatile and semivolatile organic compounds, pesticides, polychlorinated biphenyls [PCBs], metals and other inorganic ions [cyanide, chloride, sulfate, etc.]). This low-flow procedure is not designed for collection of non-aqueous phase liquid samples from wells containing light or dense non-aqueous phase liquids (LNAPLs or DNAPLs).

This procedure is flexible for various well construction types and groundwater yields. The goal of the procedure is to obtain a turbidity level of less than 10 NTUs and to achieve a water level drawdown of less than 0.3 foot during purging and sampling. If these goals cannot be achieved, sample collection can take place provided that the remaining criteria in this procedure are met.

6.7.2 Equipment

The following equipment is required (as applicable) for low-flow purging and sampling:

- Adjustable rate submersible pump (e.g., centrifugal or bladder pump constructed of stainless steel or Teflon).
- Disposable clear plastic bottom-filling bailers to be used to check for and obtain samples of LNAPLs or DNAPLs.
- Tubing Teflon, Teflon-lined polyethylene, polyethylene, polyvinyl chloride (PVC), Tygon, or stainless steel tubing can be used to collect samples for analysis, depending on the analyses to be performed and regulatory requirements.
- Water level measuring device with 0.01-foot accuracy (electronic devices are preferred for tracking water level drawdown during all pumping operations).

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- Interface probe.
- · Flow measurement supplies.
- Power source (generator, nitrogen tank, etc.). If a gasoline generator is used, it must be located downwind and at a safe distance from the well so that the exhaust fumes do not contaminate the samples.
- Indicator parameter monitoring instruments pH, turbidity, specific conductance, and temperature.
 Use of a flow-through cell is recommended. Optional indicators ORP, salinity, and DO. A flow-through cell (also referred to as an in-line sample chamber) is required.
- Standards to perform field calibration of instruments.
- Decontamination supplies.
- Logbook(s) and other forms (see Attachments B through D) or equivalent electronic form(s).
- Sample bottles.
- Sample preservation supplies (as required by the analytical methods).
- Sample tags and/or labels.
- Well construction data, location map, field data from last sampling event (if available).
- Field Sampling Plan.
- PID or FID instrument for measuring volatile organic compounds (VOCs) per the HASP.

6.7.3 Purging and Sampling Procedure

- 1. Open the monitoring well as stated earlier and step away. Prepare sampling equipment while allowing 3 to 5 minutes to allow the water level to reach equilibrium. In situations where VOCs are the primary contaminants of concern, air monitoring of the samplers' breathing zone areas may be required by the HASP (typically with a PID or FID).
- 2 Measure the water level immediately prior to placing the pump in the well and record the water level on the Low-Flow Purge Data Form or equivalent electronic form immediately prior to placing the pump or tubing into the well.
- 3. Lower the measuring device further into the well to collect the total depth measurement. Again wait 3 to 5 minutes to allow the well to equilibrate to the initial water level prior to placing the pump or pump intake in the well.
- 4. Record the total well depth on the Low-Flow Purge Data Form or equivalent electronic form immediately prior to placing the pump or tubing into the well
- 5. Lower the pump or tubing slowly into the well so that the pump intake is located at the center of the saturated screen length of the well. If possible, keep the pump intake at least 2 feet above the bottom of the well to minimize mobilization of sediment that may be present in the bottom of the well. Collection of turbidity-free water samples may be difficult if there is 3 feet or less of standing water in the well.

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- 6. Start with the initial pump rate set at approximately 0.1 liter per minute. Use a graduated cylinder and stopwatch to measure the pumping rate. Adjust the pumping rates as necessary to prevent drawdown from exceeding 0.3 foot during purging. If no drawdown is noted, the pump rate may be increased (to a maximum of 0.4 liter per minute) to expedite the purging and sampling event. The pump rate will be reduced if turbidity is greater than 10 NTUs after all other field parameters have stabilized. If groundwater is drawn down below the top of the well screen, purging shall cease or the well shall be pumped to dryness and then allowed to recover before purging continues. Well recovery to 75 percent is necessary prior to sampling. Slow-recovering wells should be identified and purged at the beginning of the workday to maximize field work efficiency. If possible, samples should be collected from these wells within the same workday and no later than 24 hours after the end of purging.
- 7. Measure the water level in the well every 5 to 10 minutes using the water level meter. Record the well water level on the Low Flow Purge Data Form (Attachment D) or equivalent electronic form.
- 8. Record on the Low Flow Purge Data Form every 5 to 10 minutes the water quality parameters (pH, specific conductance, temperature, turbidity, ORP, DO, and salinity or as specified by the approved site-specific planning document) measured by the water quality meter and turbidity meter. If the cell needs to be cleaned during purging operations, continue pumping (allow the pump to discharge into a container) and disconnect the cell. Rinse the cell with distilled/deionized water. After cleaning is completed, reconnect the flow-through cell and continue purging. Document the cell cleaning on the Low-Flow Purge Data Form or equivalent electronic form.
- 9. Estimate the flow rate by noting the amount of discharge in a graduated cylinder per unit time using a watch with a second hand. Remeasure the flow rate any time the pump rate is adjusted and periodically during purging. This will determine if a reduction in rate has occurred due to possible battery depletion.
- 10. During purging, check for the presence of bubbles in the flow-through cell. The presence of bubbles is an indication that connections are not tight. If bubbles are observed, check for loose connections and tighten, repair, or replace them as necessary to achieve a tight connection.
- 11. Wait until stabilization is achieved, or a minimum of two saturated screen volumes have been removed and three consecutive readings, taken at 5 to 10 minute intervals, are within the following limits, then begin sampling:
 - pH ±0.2 standard units
 - Specific conductance ±10%
 - Temperature ±10%
 - Turbidity less than 10 NTUs
 - DO ±10%
- 12. If the above conditions have not been met after the well has been purged for 4 hours, purging will be considered complete and sampling can begin. Record the final well stabilization parameters from the Low-Flow Purge Data Form onto the Groundwater Sample Log Form or equivalent electronic form.

NOTE: VOC samples are preferably collected first, directly into pre-preserved sample containers. Fill all sample containers by allowing the pump discharge to flow gently down the inside of the container with minimal turbulence.

13. If the water column in the pump tubing collapses (water does not completely fill the tubing) before exiting the tubing, use one of the following procedures to collect VOC samples:

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- Collect samples for non-VOC analyses first, then increase the flow rate incrementally until the water column completely fills the tubing, collect the sample for VOCs, and record the new flow rate.
- Reduce the diameter of the existing tubing until the water column fills the tubing either by adding a
 connector (Teflon or stainless steel) or clamp, which should reduce the flow rate by constricting
 the end of the tubing. Proceed with sample collection.
- Insert a narrow-diameter Teflon tube into the pump's tubing so that the end of the tubing is in the water column and the other end of the tubing protrudes beyond the pump's tubing, then collect the sample from the narrow diameter tubing.
- Prepare samples for shipping as per SOP SA-6.1.

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ATTACHMENT A

PURGING EQUIPMENT SELECTION

Diame	ter Casing	Bailer	Peristaltic Pump	Vacuum Pump	Air-lift	Diaphragm "Trash" Pump	Submersible Diaphragm Pump	Submersible Electric Pump	Submersible Electric Pump w/Packer
1.25-Inch	Water level <25 feet	Х	Х	Х	Х	Х			
	Water Level >25 feet	Х			Х				
2-Inch	Water level <25 feet	Х	Х	х	Х	Х	X		
	Water Level >25 feet	Х			Х		х		
4-Inch	Water level <25 feet	Х	Х	х	Х	Х	х	X	×
	Water Level >25 feet	X			X		х	X	X
6-Inch	Water level <25 feet				Х	Х		×	X
	Water Level >25 feet		. 1		Х			Х	X
8-Inch	Water level <25 feet				Х	Х		х	X
	Water Level >25 feet				Х		· .	X	Х

ATTACHMENT A PURGING EQUIPMENT SELECTION PAGE 2

Manufacturer	Model Name/Number	Principle of	Maximum Outside	Construction Materials (w/Lines	Lift Range	Delivery Rates or Volumes	1982 Price	Comments
		Operation	Diameter/L ength (Inches)	and Tubing)	(ft)	·	(Dollars)	
BarCad Systems, inc.	BarCad Sampler	Dedicated; gas drive (positive displacement)	1.5/16	PE, brass, nylon, aluminum oxide	0-150 with std. tubing	1 liter for each 10-15 feet of submergence	\$220-350	Requires compressed gas; custom sizes and materials available; acts as piezometer.
Cole-Parmer Inst. Co.	Master Flex 7570 Portable Sampling Pump	Portable; peristaltic (suction)	<1.0/NA	(not submersible) Tygon [®] , silicone Viton [®]	0-30	670 mL/min with 7015- 20 pump head	\$500-600	AC/DC; variable speed control available; other models may have different flow rates.
ECO Pump Corp.	SAMPLifler	Portable; venturi	<1.5 or <2.0/NA	PP, PE, PVC, SS, Teflon®, Tefzel®	0-100	0-500 mL/min depending on lift	\$400-700	AC, DC, or gasoline-driven motors available; must be primed.
Geltek Corp.	Bailer 219-4	Portable; grab (positive displacement)	1.66/38	Teflon®	No limit	1,075 mL	\$120-135	Other sizes available.
GeoEngineering, Inc.	GEO-MONITOR	Dedicated; gas drive (positive displacement)	1.5/16	PE, PP, PVC, Viton®	Probably 0-150	Approximately 1 liter for each 10 feet of submergence	\$185	Acts as piezometer, requires compressed gas.
Industrial and Environmental Analysts, Inc. (IEA)	Aquarius	Portable; bladder (positive displacement)	1.75/43	SS, Teflon®, Viton®	0-250	0-2,800 mL/min	\$1,500- 3,000	Requires compressed gas; other models available; AC, DC, manual operation possible.
IEA	Syringe Sampler	Portable; grab (positive displacement)	1.75/43	SS, Teflon®	No limit	850 mL sample volume	\$1,100	Requires vacuum and/or pressure from hand pump.
Instrument Specialties Co. (ISCO)	Model 2600 Well Sampler	Portable, bladder (positive displacement)	1.75/50	PC, silicone, Teflon®, PP, PE, Detrin®, acetal	0-150	0-7,500 mL/min	\$990	Requires compressed gas (40 psi minimum).
Keck Geophysical Instruments, Inc.	SP-81 Submersible Sampling Pump	Portable; helical rotor (positive displacement)	1.75/25	SS, Teflon®, PP, EPDM, Viton®	0-160	0-4,500 mL/min	\$3,500	DC operated.
Leonard Mold and Die Works, Inc.	GeoFilter Small Diameter Well Pump (#0500)	Portable; bladder (positive displacement)	1.75/38	SS, Teflon®, PC, Neoprene®	0-400	0-3,500 mL/min	\$1,400- 1,500	Requires compressed gas (55 psi minimum); pneumatic or AC/DC control module.
Oil Recovery Systems, Inc.	Surface Sampler	Portable; grab (positive displacement)	1.75/12	acrylic, Detrin®	No limit	Approximately 250 mL	\$125-160	Other materials and models available; for measuring thickness of "floating" contaminants.
Q.E.D. Environmental Systems, Inc.	Well Wizard® Monitoring System (P-100)	Dedicated; bladder (positive displacement)	1.66/36	PVC	0-230	0-2,000 mL/min	\$300-400	Requires compressed gas; piezometric level indicator; other materials available.

Subject

GROUNDWATER SAMPLE ACQUISITION AND ONSITE WATER QUALITY TESTING

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ATTACHMENT A PURGING EQUIPMENT SELECTION PAGE 3

Manufacturer	Model Name/Number	Principle of Operation	Maximum Outside Diameter/L ength (Inches)	Construction Materials (w/Lines and Tubing)	Lift Range (ft)	Delivery Rates or Volumes	1982 Price (Dollars)	Comments
Randolph Austin Co.	Model 500 Vari-Flow Pump	Portable; peristaltic (suction)	<0.5/NA	(Not submersible) Rubber, Tygon [®] , or Neoprene [®]	0-30	See comments	\$1,200- 1,300	Flow rate dependent on motor and tubing selected; AC operated; other models available.
Robert Bennett Co.	Model 180	Portable; piston (positive displacement)	1.8/22	SS, Teflon®, Delrin® PP, Viton®, acrylic, PE	0-500	0-1,800 mL/min	\$2,600- 2,700	Requires compressed gas; water level indicator and flow meter; custom models available.
Slope Indicator Co. (SINCO)	Model 514124 Pneumatic Water Sampler	Portable; gas drive (positive displacement)	1.9/18	PVC, nylon	0-1,100	250 mL/flushing cycle	\$250-350	Requires compressed gas; SS available; piezometer model available; dedicated model available.
Solinst Canada Ltd.	5W Water Sampler	Portable; grab (positive displacement)	1.9/27	PVC, brass, nylon, Neoprene®	0-330	500 mL	\$1,300- 1,800	Requires compressed gas; custom models available.
TIMCO Mfg. Co., Inc.	Std. Bailer	Portable; grab (positive displacement)	1.66/Custo m	PVC, PP	No limit	250 mL/ft of bailer	\$20-60	Other sizes, materials, models available; optional bottom-emptying device available; no solvents used.
TIMCO	Air or Gas Lift Sampler	Portable; gas drive (positive displacement)	1.66/30	PVC, Tygon®, Teflon®	0-150	350 mL/flushing cycle	\$100-200	Requires compressed gas; other sizes, materials, models available; no solvents used.
Tole Devices Co.	Sampling Pump	Portable; bladder (positive displacement)	1.38/48	SS, silicone, Delrine, Tygone	0-125	0-4,000 mL/min	\$800- 1,000	Compressed gas required; DC control module; custom built.

Construction Material Abbreviations:

Other Abbreviations:

PE PP

Not applicable

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PVC SS

Polyethylene Polypropylene Polyvinyl chloride

AC DC

Alternating current Direct current

PC

Stainless steel Polycarbonate

EPDM

Ethylene-propylene diene (synthetic rubber)

NOTE: Other manufacturers market pumping devices which could be used for groundwater sampling, though not expressly designed for this purpose. The list is not meant to be all-inclusive and listing does not constitute endorsement for use. Information in the table is from sales literature and/or personal communication. No skimmer, scavenger-type, or high-capacity pumps are included.

Source: Barcelona et al., 1983.

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ATTACHMENT B GROUNDWATER SAMPLE LOG SHEET

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ATTACHMENT C EQUIPMENT CALIBRATION LOG

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STANDARD OPERATING PROCEDURES

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Applicability

Tetra Tech NUS, Inc.

Prepared

Earth Sciences Department

Subject

SURFACE WATER AND SEDIMENT SAMPLING

Approved

Tom Johnston



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1.0 PURPOSE

This Standard Operating Procedure (SOP) describes procedures and equipment commonly used for collecting environmental samples of surface water and aquatic sediment for either onsite examination and chemical testing or for offsite laboratory analysis.

2.0 SCOPE

The information presented in this document is applicable to all environmental sampling of surface waters (Section 5.3) and aquatic sediments (Section 5.5), except where the analyte(s) may interact with the sampling equipment. The collection of concentrated sludges or hazardous waste samples from disposal or process lagoons often requires methods, precautions, and equipment different from those described herein.

3.0 GLOSSARY

Analyte - Chemical or radiochemical material whose concentration, activity, or mass is measured.

<u>Composite Sample</u> – A sample representing a physical average of grab samples.

<u>Environmental Sample</u> – A quantity of material collected in support of an environmental investigation that does not require special handling or transport considerations as detailed in SOP SA-6.1.

<u>Grab Sample</u> – A portion of material collected to represent material or conditions present at a single unit of space and time.

<u>Hazardous Waste Sample</u> – A sample containing (or suspected to contain) concentrations of contaminants that are high enough to require special handling and/or transport considerations per SOP SA-6.1.

Representativeness – A qualitative description of the degree to which an individual sample accurately reflects population characteristics or parameter variations at a sampling point. It is therefore an important characteristic not only of assessment and quantification of environmental threats posed by the site, but also for providing information for engineering design and construction. Proper sample location selection and proper sample collection methods are important to ensure that a truly representative sample has been collected.

4.0 RESPONSIBILITIES AND PERSONNEL QUALIFICATIONS

<u>Project Manager</u> - The Project Manager is responsible for determining the sampling objectives, initial sampling locations, and field procedures used in the collection of soil samples. The Project Manager also has the overall responsibility for seeing that all surface water and sediment sampling activities are properly conducted by appropriately trained personnel in accordance with applicable planning documents.

<u>Field Operations Leader</u> - This individual is primarily responsible for the execution of the planning document containing the Sampling and Analysis Plan (SAP). This is accomplished through management of a field sampling team for the proper acquisition of samples. He or she is responsible for the supervision of onsite analyses; ensuring proper instrument calibration, care, and maintenance; sample collection and handling; the completion and accuracy of all field documentation; and making sure that

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custody of all samples obtained is maintained according to proper procedures. When appropriate and as directed by the FOL, such responsibilities may be performed by other qualified personnel (e.g., field technicians) where credentials and time permit. The FOL is responsible for finalizing the locations for collection of surface water and sediment samples. The FOL is ultimately responsible for adherence to Occupational Safety and Health Administration (OSHA) regulations during these operations through self acquisition or through the management of a field team of samplers.

<u>Site Safety Officer (SSO)</u> - The SSO (or a qualified designee) is responsible for providing the technical support necessary to implement the project Health and Safety Plan (HASP). This includes but is not be limited to performing air quality monitoring during sampling and boring and excavation activities, and ensuring that workers and offsite (downwind) individuals are not exposed to hazardous levels of airborne contaminants. The SSO or SSO designee may also be required to advise the FOL on other safety-related matters regarding boring and sampling, such as mitigative measures to address potential hazards from hazardous objects or conditions.

<u>Project Geologist/Sampler</u> - The project geologist/sampler is responsible for the proper acquisition of samples in accordance with this SOP and other project-specific documents. In addition, this individual is responsible for the completion of all required paperwork (e.g., sample log sheets, field notebook, , container labels, custody seals, and chain-of-custody forms) associated with the collection of those samples.

General personnel qualifications for groundwater sample collection and onsite water quality testing include the following:

- Occupational Safety and Health Administration (OSHA) 40-hour and applicable refresher training.
- Capability of performing field work under the expected physical and environmental (i.e., weather) conditions.
- Familiarity with appropriate procedures for sample documentation, handling, packaging, and shipping.

5.0 HEALTH AND SAFETY

Precautions to preserve the health and safety of field personnel implementing this SOP are distributed throughout. The following general hazards may also exist during field activities, and the means of avoiding them must be used to preserve the health and safety of field personnel:

Bridge/Boat Sampling – Potential hazards associated with this activity include:

- Traffic one of the primary concerns as samplers move across a bridge because free space of travel is not often provided. Control measures should include:
 - When sampling from a bridge, if the samplers do not have at least 6 feet of free travel space or physical barriers separating them and the traffic patterns, the HASP will include a Traffic Control Plan.
 - The use of warning signs and high-visibility vests are required to warn oncoming traffic and to increase the visibility of sample personnel.
- Slips, trips, and falls from elevated surfaces are a primary concern. Fall protection shall be worn when or if samplers must lean over a rail to obtain sample material. A Fall Protection Competent

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Person (in accordance with Occupational safety and Health Administration [OSHA] fall protection standards) must be assigned to ensure that fall protection is appropriately and effectively employed

- Water hazards/drowning if someone enters the water from an elevated surface (such as a bridge or dock) and when sampling from a boat. To minimize this potential, personnel shall wear United states Coast Guard (USCG)-approved floatation devices, and the sampling crew must also have on hand a Type IV Throwable Personal Floatation Device with at least 90 feet of 3/8-inch rope. See Section 5.5.2 of this SOP.
- Within the HASP, provisions will also be provided concerning the requirement of a Safe Vessel Certification or the necessity to conduct a boat inspection prior to use. In addition, the HASP shall also specify requirements as to whether the operator must be certified as a commercial boat operator and whether members of the sampling team must have a state-specific safe boating certification.

Entering Water to Collect Samples – Several hazards are associated with this activity and can be mitigated as follows:

- Personnel must wear a USCG-approved Floatation Device (selected and identified in the HASP).
 The SSO shall ensure that the device selected is in acceptable condition and suitable for the individual using it. This includes consideration of the weight of the individual.
- Lifelines shall be employed from a point on the shore. This activity will always be conducted with a Buddy. See Section 6.5.2.
- Personnel shall carry a probe to monitor the bottom ahead of them for drop offs or other associated hazards.
- The person in the water shall exercise caution concerning the path traveled so that the lifeline does not become entangled in underwater obstructions such as logs, branches, stumps, etc., thereby restricting its effectiveness in extracting the person from the water.
- Personnel shall not enter waters on foot in situations where natural hazards including alligators, snakes, as well as sharks, gars, and other predators within inland waterways may exist.
- In all cases, working along and/or entering the water during high currents or flood conditions shall be prohibited.
- Personnel shall not enter bodies of water where known debris exists that could result in injuries from cuts and lacerations.

Sampling in marshes or tidal areas in some instances can be accomplished using an all-terrain vehicle (ATV). This is not the primary recommended approach because the vehicle may become disabled, or weather conditions or tidal changes could result in environmental damage as well as loss of the vehicle. The primary approach is recommended to be on foot where minimal disturbance would occur. The same precautions specified above with regard to sediment disturbance apply as well as the previously described safety concerns associated with natural hazards. The natural hazards include alligators, bees (nests in dead falls and tree trunks), snakes, etc. In addition, moving through and over this terrain is difficult and could result in muscle strain and slips, trips, and falls. Common sense dictates that the sampler selects the most open accessible route over moderate terrain. Move slowly and deliberately through challenging terrain to minimize falls. Mud boots or other supportive PPE should be considered and specified in the HASP to permit samplers to move over soft terrain with the least amount of effort. In these situations, it is also recommended, as the terrain allows, that supplies be loaded and transported in a sled over the soft ground.

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Working in these areas, also recognize the following hazards and means of protection against them:

Insects are also a primary concern. These include mosquitoes, ticks, spiders, bees, ants, etc. The HASP will identify those particular to your area. Typical preventative measures include:

- Use insect repellant. Approval of various repellants should be approved by the Project Chemist or Project Manager.
- Wearing light-colored clothing to control heat load due to excessive temperatures. In addition, it
 makes it easier to detect crawling insects on your clothing.
- Taping pants to boots to deny access. Again, this is recommended to control access to the skin by crawling insects. Consultation with the Project Health and Safety Officer SSO/Health and Safety Manager is recommended under extreme heat loads because this will create conditions of heat stress.
- Performing a body check to remove insects. The quicker you remove ticks, the less likely they will become attached and transfer bacteria to your bloodstream. Have your Buddy check areas inaccessible to yourself. This includes areas such as the upper back and between shoulder blades where it is difficult for you to examine and even more difficult for you to remove.

Safety Reminder

If you are allergic to bee or ant stings, it is especially critical that you carry your doctor-recommended antidote with you in these remote sampling locations due to the extended time required to extract incapacitated individuals as well as the effort required to extract them. In these scenarios, instruct your Buddy in the proper administration of the antidote. In all cases, if you have received a sting, administer the antidote regardless of the immediate reaction, evacuate, and seek medical attention as necessary. The FOL and/or SSO will determine when and if you may return to the field based on the extent of the immune response and hazards or potential hazards identified in these locations. To the FOL and SSO, this is a serious decision you have to make as to whether to take someone vulnerable to these hazards into a remote location where you may not be able to carry them out. Consider it wisely.

Poisonous Plants – To minimize the potential of encountering poisonous plants in the field, at least one member of the field team needs to have basic knowledge of what these plants look like so that they can be recognized, pointed out to other field personnel, and avoided if at all possible. If the field team cannot avoid contact and must move through an area where these plants exist, the level of personal protective equipment (PPE) shall include Tyvek coveralls and enhanced decontamination procedures for the removal of oils from the tooling and/or equipment.

Temperature-Related Stress – Excessively cold temperatures may result in cold stress, especially when entering the water either intentionally or by accident. Provisions for combating this hazard should be maintained at the sample location during this activity. Excessively hot temperatures may result in heat stress especially in scenarios where equipment is packed through the marsh.

Because all of these activities are conducted outside, electrical storms are a significant concern. The following measures will be incorporated to minimize this hazard:

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- Where possible, utilize commercial warning systems and weather alerts to detect storms moving into the area.
- If on or in the water, get out of the water. Move to vehicles or preferably into enclosed buildings with plumbing and wiring.
- Where warning systems are not available, follow the 30/30 Rule (if there are less than 30 seconds between thunder and lightning, go inside for at least 30 minutes after the last thunder).

See Section 4.0 of the Health and Safety Guidance Manual (HSGM) for additional protective measures.

6.0 PROCEDURES

6.1 Introduction

Collecting a representative sample of surface water or sediment may be difficult because of water movement, stratification, or heterogeneous distribution of the targeted analytes. To collect representative samples, one must standardize sampling methods related to site selection, sampling frequency, sample collection, sampling devices, and sample handling, preservation, and identification. Regardless of quality control applied during laboratory analyses and subsequent scrutiny of analytical data packages, reported data are no better than the confidence that can be placed in the representativeness of the samples. Consult Appendix C for guidance on sampling that should be considered during project planning and that may be helpful to field personnel.

6.1.1 Surface Water Sampling Equipment

The selection of sampling equipment depends on the site conditions and sample type to be acquired. In general, the most representative samples are obtained from mid-channel at a stream depth of 0.5 foot in a well-mixed stream; however, project-specific planning documents will address site-specific sampling requirements including sample collection points and sampling equipment. The most frequently used samplers include the following:

- Peristaltic pump
- Bailer
- Dip sampler
- Weighted bottle
- Hand pump
- Kemmerer
- Depth-integrating sampler

The dip sampler and weighted bottle sampler are used most often, and detailed discussions for these devices and the Kemmerer sampler are addressed subsequently in this section.

The criteria for selecting a sampler include:

- 1. Disposability and/or easy decontamination.
- 2. Inexpensive cost (if the item is to be disposed).
- 3. Ease of operation.

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4. Non-reactive/non-contaminating properties - Teflon-coated, glass, stainless-steel or polyvinyl chloride (PVC) sample chambers are preferred (in that order).

Measurements collected for each sample (grab or each aliquot collected for compositing) shall include but not be limited to:

- Specific conductance
- Temperature
- pH
- Dissolved oxygen

Sample measurements shall be conducted as soon as the sample is acquired. Measurement techniques described in SOP SA-1.1 shall be followed. All pertinent data and results shall be recorded in a field notebook or on sample log sheets (see Attachment A) or an equivalent electronic form(s). These analyses may be selected to provide information on water mixing/stratification and potential contamination. Various types of water bodies have differing potentials for mixing and stratification.

In general, the following equipment if necessary for obtaining surface water samples:

- Required sampling equipment, which may include a remote sampling pole, weighted bottle sampler, Kemmerer sampler, or other device.
- Real-time air monitoring instrument (e.g., PID, FID) as directed in the project-specific planning document.
- Required PPE as directed in the project-specific planning document, which may include:
 - Nitrile surgeon's or latex gloves (layered as necessary).
 - Safety glasses.
 - Other items identified on the Safe Work Permit that may be required based on location-specific requirements (e.g., hearing protection, steel-toed work boots, hard hat). These provisions will be listed in the HASP or addressed by the FOL and/or SSO.

Safety Reminder

The use of latex products may elicit an allergic reaction in some people. Should this occur, remove the latex gloves, treat for an allergic reaction, and seek medical attention as necessary.

- Required paperwork (see SOP SA-6.3 and Attachments A and B to this SOP).
- Required decontamination equipment.
- Required sample containers.
- Sealable polyethylene bags (e.g., Ziploc® baggies).
- Heavy-duty cooler.
- Ice.

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- Paper towels and garbage bags.
- Chain-of-custody records and custody seals.

Dip Sampling

Specific procedures for collecting a dip or grab sample of surface water can vary based on site-specific conditions (e.g., conditions near the shore and how closely a sampler can safely get to the shore). The general procedure for collecting a sample using a pole or directly from the water body is as follows:

- If using a remote sampling pole, securely attach the appropriate sample container to a pole of sufficient length to reach the water to be sampled. Samples for volatile analysis should be collected first. Use PPE as described in the HASP. When sample containers are provided pre-preserved or if the pole cannot accommodate a particular sample container, use a dedicated, clean, unpreserved bottle/container for sampling and transfer to an appropriately preserved container.
- 2. Remove the cap. Do not place the cap on the ground or elsewhere where it might become contaminated.
- 3. Carefully dip the container into the water just below the surface (or as directed by project-specific planning documents), and allow the bottle to fill. Sample bottles for volatile analysis must be filled with no headspace. Avoid contacting the bottom of the water body because this will disturb sediment that may interfere with the surface water sample.
- 4. Retrieve the container and carefully replace the cap securely. If using a container other than the sample bottle, pour the water from that container into the sample bottle and replace the cap securely.
- 5. Use a clean paper towel to clean and dry the outside of the container.
- 6. Affix a sample label to each container, ensuring that each label is completely carefully, clearly, and completely, addressing all of the categories described in SOP SA-6.3.
- 7. Proceed with the handling and processing of each sample container as described in SOP SA-6.2.

Constituents measured in grab samples collected near the water surface are only indicative of conditions near the surface of the water and may not be a true representation of the total concentration distributed throughout the water column and in the cross section. Therefore, as possible based on site conditions, the sampler may be required to augment dip samples with samples that represent both dissolved and suspended constituents and both vertical and horizontal distributions.

CAUTION

In areas prone to natural hazards such as alligators and snakes, etc., always use a buddy as a watch. Always have and use a lifeline or throwable device to extract persons who could potentially fall into the water. Be attentive to the signs, possible mounds indicating nests, and possible slides into the water. Remember that although snakes are typically encountered on the ground, it is not unheard of to see them on low-hanging branches. Be attentive to your surroundings because these may indicate that hazards are nearby.

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Weighted Bottle Sampling

A grab sample can also be collected using a weighted holder that allows a bottle to be lowered to any desired depth, opened for filling, closed, and returned to the surface. This allows discrete sampling with depth. Several of these samples can be combined to provide a vertical composite. Alternatively, an open bottle can be lowered to the bottom and raised to the surface at a uniform rate so that the bottle collects sample throughout the total depth and is just filled on reaching the surface. The resulting sample using either method will roughly approach what is known as a depth-integrated sample.

A closed weighted bottle sampler consists of glass or plastic bottle with a stopper, a weight and/or holding device, and lines to open the stopper and lower or raise the bottle. The general procedure for sampling with this device is as follows:

- 1. Gently lower the sampler to the desired depth so as not to remove the stopper prematurely (watch for bubbles).
- 2. When the desired depth is reached, pull out the stopper with a sharp jerk of the stopper line.
- 3. Allow the bottle to fill completely, as evidenced by the absence of air bubbles.
- 4. Raise the sampler and cap the bottle.
- 5. Use a paper towel to clean and dry the outside of the container. This bottle can be used as the sample container as long as the bottle is an approved container type.
- 6. Affix a sample label to each container, ensuring that each label is completely carefully, clearly, and completely, addressing all of the categories described in SOP SA-6.3.
- 7. Proceed with the handling and processing of each sample container as described in SOP SA-6.2.

Kemmerer Sampler

If samples are desired at a specific depth, and the parameters to be measured do not require a Teflon-coated sampler, a standard Kemmerer sampler may be used. The Kemmerer sampler is a brass, stainless steel or acrylic cylinder with rubber stoppers that leave the ends open while it is lowered in a vertical position (thus allowing free passage of water through the cylinder). A "messenger" is sent down the line when the sampler is at the designated depth to cause the stoppers to close the cylinder, which is then raised. Water is removed through a valve to fill sample bottles. The general procedure for sampling with this device is as follows:

- 1. Gently lower the sampler to the desired depth.
- 2. When the desired depth is reached, send down the messenger to close the cylinder and then raise the sampler.
- 3. Open the sampler valve to fill each sample bottle (filling bottles for volatile analysis first).
- 4. Use a paper towel to clean and dry the outside of the container.
- 5. Affix a sample label to each container, ensuring that each label is completely carefully, clearly, and completely, addressing all of the categories described in SOP SA-6.3.
- 6. Proceed with the handling and processing of each sample container as described in SOP SA-6.2.

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6.1.2 Surface Water Sampling Techniques

Samples collected during site investigations may be grab samples or composite samples. The following general procedures apply to various types of surface water collection techniques:

- If a clean, pre-preserved sample container is not used, rinse the sample container least once with the
 water to be sampled before the sample is collected. This is not applicable when sample containers
 are provided pre-preserved because doing so will wash some or all of the preservative out of the
 bottle.
- For sampling moving water, collect the farthest downstream sample first, and continue sample collection in an upstream direction. In general, work from zones suspected of low contamination to zones of high contamination.
- Take care to avoid excessive agitation of the water because loss of volatile constituents could result.
- When obtaining samples in 40 mL vials with septum-lined lids for volatile organics analysis, fill the container completely (with a meniscus) to exclude any air space in the top of the bottle and to be sure that the Teflon liner of the septum faces in after the vial is filled and capped. Turn the vial upside down and tap gently on your wrist to check for air bubbles. If air bubbles rise in the bottle, add additional sample volume to the container.
- Do not sample at the surface, unless sampling specifically for a known constituent that is immiscible and on top of the water. Instead, invert the sample container, lower it to the approximate depth, and hold it at about a 45-degree angle with the mouth of the bottle facing upstream.

6.2 Onsite Water Quality Testing

Onsite water quality testing shall be conducted as described in SOP SA-1.1.

6.3 <u>Sediment Sampling</u>

6.3.1 General

If composite surface water samples are collected, sediment samples are usually collected at the same locations as the associated surface water samples. If only one sediment sample is to be collected, the sampling location shall be approximately at the center of the water body, in a depositional area if possible based on sample location restraints (see below), unless the SAP states otherwise.

Generally, coarser-grained sediments are deposited near the headwaters of reservoirs. Bed sediments near the center of a water body will be composed of fine-grained materials that may, because of their lower porosity and greater surface area available for adsorption, contain greater concentrations of contaminants. The shape, flow pattern, bathymetry (i.e., depth distribution), and water circulation patterns must all be considered when selecting sediment sampling sites. In streams, areas likely to have sediment accumulation (e.g., bends, behind islands or boulders, quiet shallow areas or very deep, low-velocity areas) shall be sampled, in general, and areas likely to show net erosion (i.e., high-velocity, turbulent areas) and suspension of fine solid materials shall be generally avoided. Follow instructions in the SAP, as applicable.

Chemical constituents associated with bottom material may reflect an integration of chemical and biological processes. Bottom samples reflect the historical input to streams, lakes, and estuaries with

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respect to time, application of chemicals, and land use. Bottom sediments (especially fine-grained material) may act as a sink or reservoir for adsorbed heavy metals and organic contaminants (even if water column concentrations are less than detection limits). Therefore, it is important to minimize the loss of low-density "fines" during any sampling process.

Samples collected for volatile organic compound (VOC) analysis must be collected prior to any sample homogenization. Regardless of the method used for collection, the aliquot for VOC analysis must be collected directly from the sampling device (hand auger bucket, scoop, trowel), to the extent practical. If a device such as a dredge is used, the aliquot should be collected after the sample is placed in the mixing container prior to mixing.

In some cases, the sediment may be soft and not lend itself to collection by plunging EncoreTM or syringe samplers into the sample matrix. In these cases, it is appropriate to open the sampling device, (Encore barrel or syringe) prior to sample collection, and carefully place the sediment in the device, filling it fully with the required volume of sample.

On active or former military sites, ordnance items may be encountered in some work areas. Care should be exercised when handling site media (such as if unloading a dredge as these materials may be scooped up). If suspected ordnance items are encountered, stop work immediately, move to shore and notify the Project Manager and Health and Safety Manager.

All relevant information pertaining to sediment sampling shall be documented as applicably described in SOP SA-6.3 and Attachment B or an equivalent electronic form.

6.3.2 Sampling Equipment and Techniques for Bottom Materials

A bottom-material sample may consist of a single scoop or core, or may be a composite of several individual samples in the cross section. Sediment samples may be obtained using onshore or offshore techniques.

SAFETY REMINDER

The following health and safety provisions apply when working on/over/near water:

- At least two people are required to be present at the sampling location in situations where the water depth and/or movement deem it necessary, each wearing a USCG-approved Personal Flotation Devices
- A minimum of three people are required if <u>any</u> of the following conditions are anticipated or observed:
 - Work in a waterway that is turbulent <u>or</u> swift that could sweep a sampler down stream should he or she fall in accidentally.
 - The underwater walking surface (e.g., stream/river bed) is suspected or observed to involve conditions that increase the potential for a worker to fall into the water. Examples include large/uneven rocks or boulders, dense mud or sediment that could entrap worker's feet, etc.
 - Waterway is tidal, and conditions such as those listed above could rapidly change.

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The third person in the above condition must be equipped and prepared to render emergency support [e.g., lifeline, tethered Personal Flotation Device (Throwable Type IV, life saver), skiff, means to contact external emergency response support, etc.]

The following samplers may be used to collect sediment samples:

- Scoop sampler
- Dredge samplers
- Coring samplers

Each type of sampler is discussed below.

In general, the following equipment if necessary for obtaining sediment samples:

- Required sampling equipment, which may include a scoop sampler, dredge sampler, coring sampler, or stainless steel or pre-cleaned disposable trowel.
- Stainless bowl or pre-cleaned disposable bowl to homogenize sample.
- Real-time air monitoring instrument (e.g., PID, FID) as directed in the project-specific planning document.
- Required PPE as directed in the project-specific planning document, which may include:
 - Nitrile surgeon's or latex gloves (layered as necessary).
 - Safety glasses.
 - Other items identified on the Safe Work Permit that may be required based on location-specific requirements (e.g., hearing protection, steel-toed work boots, hard hat). These provisions will be listed in the HASP or addressed by the FOL and/or SSO.
 - Required paperwork (see SOP SA-6.3 and Attachments A and B to this SOP).
 - Required decontamination equipment.
 - Required sample containers.
 - Sealable polyethylene bags (e.g., Ziploc® baggies).
 - Heavy-duty cooler.
 - Ice.
 - Paper towels and garbage bags.
 - Chain-of-custody records and custody seals.

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Scoop Sampler

A scoop sampler consists of a pole to which a jar or scoop is attached. The pole may be made of bamboo, wood, PVC, or aluminum and be either telescoping or of fixed length. The scoop or jar at the end of the pole is usually attached using a clamp.

If the water body can be sampled from the shore or if the sampler can safely wade to the required location, the easiest and best way to collect a sediment sample is to use a scoop sampler. Scoop sampling also reduces the potential for cross-contamination. The general scoop sampling procedure is as follows:

- 1. Reach over or wade into the water body.
- 2. While facing upstream (into the current), scoop the sampler along the bottom in an upstream direction. Although it is very difficult not to disturb fine-grained materials at the sediment-water interface when using this method, try to keep disturbances to a minimum.

Dredge Samplers

Dredges are generally used to sample sediments that cannot easily be obtained using coring devices (e.g., coarse-grained or partially cemented materials) or when large quantities of sample are required. Dredges generally consist of a clam shell arrangement of two buckets. The buckets may either close upon impact or be activated by use of a "messenger." Some dredges are heavy and may require use of a winch and crane assembly for sample retrieval. The three major types of dredges are Peterson, Eckman and Ponar.

The Peterson dredge is used when the bottom is rocky, in very deep water, or when the flow velocity is high. The Peterson dredge shall be lowered very slowly as it approaches bottom, because it can force out and miss lighter materials if allowed to drop freely.

The Eckman dredge has only limited usefulness. It performs well where bottom material is unusually soft, as when covered with organic sludge or light mud. It is unsuitable, however, for sandy, rocky, and hard bottoms and is too light for use in streams with high flow velocities.

The Ponar dredge is a Peterson dredge modified by the addition of side plates and a screen on the top of the sample compartment. The screen over the sample compartment permits water to pass through the sampler as it descends, thus reducing the "shock wave." The Ponar dredge is easily operated by one person in the same fashion as the Peterson dredge. The Ponar dredge is one of the most effective samplers for general use on all types of substrates.

The general procedure for using dredge samplers is as follows:

- 1. Gently lower the dredge to the desired depth.
- 2. When the desired depth is reached, send the messenger down to cable to close the cylinder and then carefully raise the sampler.
- 3. Open the sampler to retrieve the sediment.
- 4. Transfer the sediment to the bowl in which it will be homogenized. Fill the sample bottle(s) for volatile analysis *prior to* homogenization. Homogenize the remainder of the sediment collected.
- 5. Fill the containers for all analyses other and VOCs.

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- 6. Use a paper towel to clean and dry the outside of each container.
- 7. Affix a sample label to each container, ensuring that each label is completely carefully, clearly, and completely, addressing all of the categories described in SOP SA-6.3.
- 8. Proceed with the handling and processing of each sample container as described in SOP SA-6.2.

SAFETY REMINDER

Safety concerns using these dredges include lifting hazards, pinches, and compressions (several pinch points exist within the jaws and levers). In all cases, handle the dredge by the rope to avoid capturing fingers/hands.

Coring Samplers

Coring samplers are used to sample vertical columns of sediment. Many types of coring devices have been developed depending on the depth of water from which the sample is to be obtained, the nature of the bottom material, and the length of core to be collected. They vary from hand-push tubes to electronic vibrational core tube drivers.

Coring devices are particularly useful in pollutant monitoring because turbulence created by descent through the water is minimal, thus the fines at the sediment-water interface are only minimally disturbed. The sample is withdrawn intact, permitting the removal of only those layers of interest.

In shallow, wadeable waters, the use of a core liner or tube manufactured of Teflon or plastic is recommended for the collection of sediment samples. Caution should be exercised not to disturb the bottom sediments when the sample is obtained by wading in shallow water. The general procedure to collecting a sediment sample with a core tube is as follows:

- 1. Push the tube into the substrate until 4 inches or less of the tube is above the sediment-water interface. When sampling hard or coarse substrates, a gentle rotation of the tube while it is being pushed will facilitate greater penetration and decrease core compaction.
- 2. Cop the top of the tube to provide suction and reduce the chance of losing the sample.
- 3. Slowly extract the tube so as not to lose sediment from the bottom of the tube. Cap the bottom of the tube before removing it from the water. This will also help to minimize loss of sample.
- 4. Transfer the sediment to the bowl in which it will be homogenized. Fill the sample bottle(s) for volatile analysis prior to homogenization. Homogenize the remainder of the sediment collected.
- 5. Fill the containers for all analyses other and VOCs.
- 6. Use a paper towel to clean and dry the outside of each container.
- 7. Affix a sample label to each container, ensuring that each label is completely carefully, clearly, and completely, addressing all of the categories described in SOP SA-6.3.
- 8. Proceed with the handling and processing of each sample container as described in SOP SA-6.2.

In deeper, non-wadeable water bodies, sediment cores may be collected from a bridge or boat using different coring devices such as Ogeechee Sand Pounders, gravity cores, and vibrating coring devices.

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All three devices utilize a core barrel with a core liner tube system. The core liners can be removed from the core barrel and replaced with a clean core liner after each sample. Before extracting the sediment from the coring tubes, the clear supernatant above the sediment-water interface in the core should be decanted from the tube. This is accomplished by turning the core tube to its side and gently pouring the liquid out until fine sediment particles appear in the waste liquid. Post-retrieval processing of samples is the same as above.

7.0 REFERENCES

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ATTACHMENT B SOIL & SEDIMENT SAMPLE LOG SHEET

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APPENDIX C GUIDANCE ON SAMPLING DESIGN AND SAMPLE COLLECTION

C.1 <u>Defining the Sampling Program</u>

Many factors are considered in developing a sampling program for surface water and/or sediment, including study objectives, accessibility, site topography, physical characteristics of the water body (e.g., flow and mixing), point and diffuse sources of contamination, and personnel and equipment available to conduct the study. For waterborne constituents, dispersion depends on vertical and lateral mixing within the body of water. For sediment, dispersion depends on bottom current or flow characteristics, sediment characteristics (e.g., density, size), and geochemical properties (that affect adsorption/desorption). The hydrogeologist developing the sampling plan must therefore know not only the mixing characteristics of streams and lakes but must also understand the role of fluvial-sediment transport, deposition, and chemical sorption.

C.1.1 Sampling Program Objectives

The scope of the sampling program must consider the sources and potential pathways for transport of contamination to or within a surface water body. Sources may include point sources (leaky tanks, outfalls, etc.) or nonpoint sources (e.g., contaminated runoff). The major pathways for surface water contamination (not including airborne deposition) are overland runoff, leachate influx to the water body, direct waste disposal (solid or liquid) into the water body, and groundwater flow influx from upgradient. The relative importance of these pathways, and therefore the design of the sampling program, is controlled by the physiographic and hydrologic features of the site, the drainage basin(s) that encompasses the site, and the history of site activities.

Physiographic and hydrologic features to be considered include slopes and runoff direction, areas of temporary flooding or pooling, tidal effects, artificial surface runoff controls such as berms or drainage ditches (and when they were constructed relative to site operation), and locations of springs, seeps, marshes, etc. In addition, the obvious considerations such as the locations of man-made discharge points to the nearest stream (intermittent or flowing), pond, lake, estuary, etc. shall be considered.

A more subtle consideration in designing the sampling program is the potential for dispersion of dissolved or sediment-associated contaminants away from the source. The dispersion could lead to a more homogeneous distribution of contamination at low or possibly non-detectable concentrations. Such dispersion does not, however, always readily occur. For example, obtaining a representative sample of contamination from a main stream immediately below an outfall or a tributary is difficult because the inflow frequently follows a stream bank with little lateral mixing for some distance. Sampling alternatives to overcome this situation include: (1) moving the sampling location far enough downstream to allow for adequate mixing, or (2) collecting integrated samples in a cross section. Also, non-homogeneous distribution is a particular problem with regard to sediment-associated contaminants, which may accumulate in low-energy environments (coves, river bends, deep spots, or even behind boulders) near or distant from the source while higher-energy areas (main stream channels) near the source may show no contaminant accumulation.

The distribution of particulates within a sample itself is an important consideration. Many organic compounds are only slightly water soluble and tend to adsorb onto particulate matter. Nitrogen, phosphorus, and heavy metals may also be transported by particulates. Samples must be collected with a representative amount of suspended material; transfer from the sampling device shall include transferring a proportionate amount of the suspended material.

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C.1.2 Location of Sampling Stations

Accessibility is the primary factor affecting sampling costs. The desirability and utility of a sample for analysis and consideration of site conditions must be balanced against the costs of collection as controlled by accessibility. Bridges or piers are the first choice for locating a sampling station on a stream because bridges provide ready access and also permit the sampling technician to sample any point across the stream. A boat or pontoon (with an associated increase in cost) may be needed to sample locations on lakes, reservoirs, or larger rivers. Frequently, however, a boat will take longer to cross a water body and will hinder manipulation of the sampling equipment. Wading for samples is not recommended unless it is known that contaminant levels are low so that skin contact will not produce adverse health effects. This provides a built in margin of safety in the event that wading boots or other protective equipment should fail to function properly. If it is necessary to wade into the water body to obtain a sample, the sampler shall be careful to minimize disturbance of bottom sediments and must enter the water body downstream of the sampling location. If necessary, the sampling technician shall wait for the sediments to settle before taking a sample.

Under ideal and uniform contaminant dispersion conditions in a flowing stream, the same concentrations of each contaminant would occur at all points along the cross section. This situation is most likely downstream of areas of high turbulence. Careful site selection is needed to ensure, as nearly as possible, that samples are taken where uniform flow or deposition and good mixing conditions exist.

The availability of stream flow and sediment discharge records can be an important consideration in choosing sampling sites in streams. Stream flow data in association with contaminant concentration data are essential for estimating the total contaminant loads carried by the stream. If a gaging station is not conveniently located on a selected stream, the project hydrogeologist shall explore the possibility of obtaining stream flow data by direct or indirect methods. Remember these locations are also where you may encounter natural hazards as these are areas where they hunt. Always exercise extreme caution.

C.1.3 Frequency of Sampling

The sampling frequency and objectives of the sampling event will be defined by the project planning documents. For single-event site or area characterization sampling, both bottom material and overlying water samples shall be collected at the specified sampling stations. If valid data are available on the distribution of a contaminant between the solid and aqueous phases, it may be appropriate to sample only one phase, although this is not often recommended. If samples are collected primarily for monitoring purposes (i.e., consisting of repetitive, continuing measurements to define variations and trends at a given location), water samples should be collected at a pre-established and constant interval as specified in the project plans (often monthly or quarterly and during droughts and floods). Samples of bottom material should generally be collected from fresh deposits at least yearly, and preferably seasonally, during both spring and fall.

The variability in available water quality data shall be evaluated before determining the number and collection frequency of samples required to maintain an effective monitoring program.

C.2 <u>Surface Water Sample Collection</u>

C.2.1 Streams, Rivers, Outfalls and Drainage Features

Methods for sampling streams, rivers, outfalls, and drainage features (ditches, culverts) at a single point vary from the simplest of hand-sampling procedures to the more sophisticated multi-point sampling techniques known as the equal-width-increment (EWI) method or the equal-discharge-increment (EDI) methods (see below).

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Samples from different depths or cross-sectional locations in the watercourse taken during the same sampling episode shall be composited. However, samples collected along the length of the watercourse or at different times may reflect differing inputs or dilutions and therefore shall not be composited. Generally, the number and type of samples to be taken depend on the river's width, depth, and discharge and on the suspended sediment the stream or river transports. The greater the number of individual points that are sampled, the more likely that the composite sample will truly represent the overall characteristics of the water.

In small streams less than about 20 feet wide, a sampling site can generally be found where the water is well mixed. In such cases, a single grab sample taken at mid-depth in the center of the channel is adequate to represent the entire cross section.

For larger streams, at least one vertical composite shall be taken with one sample each from just below the surface, at mid-depth, and just above the bottom. The measurement of dissolved oxygen (DO), pH, temperature, conductivity, etc., shall be made on each aliquot of the vertical composite and on the composite itself. For rivers, several vertical composites shall be collected, as directed in the project planning documents.

C.2.2 Lakes, Ponds and Reservoirs

Lakes, ponds, and reservoirs have a much greater tendency to stratify than rivers and streams. The relative lack of mixing requires that more samples be obtained. The number of water sampling sites on a lake, pond, or impoundment will vary with the size and shape of the basin. In ponds and small lakes, a single vertical composite at the deepest point may be sufficient. Similarly, measurement of DO, pH, temperature, etc. is to be conducted on each aliquot of the vertical composite and on the composite itself. In naturally formed ponds, the deepest point may have to be determined empirically; in impoundments, the deepest point is usually near the dam.

In lakes and larger reservoirs, several vertical composites shall be composited to form a single sample if a sample representative of the water column is required. These vertical composites are often collected along a transect or grid. In some cases, it may be of interest to form separate composites of epilimnetic and hypolimnetic zones. In a stratified lake, the epilimnion is the thermocline that is exposed to the atmosphere. The hypolimnion is the lower, "confined" layer that is only mixed with the epilimnion and vented to the atmosphere during seasonal "overturn" (when density stratification disappears). These two zones may thus have very different concentrations of contaminants if input is only to one zone, if the contaminants are volatile (and therefore vented from the epilimnion but not the hypolimnion), or if the epilimnion only is involved in short-term flushing (i.e., inflow from or outflow to shallow streams). Normally, however, a composite consists of several vertical composites with samples collected at various depths.

In lakes with irregular shape and with bays and coves that are protected from the wind, separate composite samples may be needed to adequately represent water quality because it is likely that only poor mixing will occur. Similarly, additional samples are recommended where discharges, tributaries, land use characteristics, and other such factors are suspected of influencing water quality.

Many lake measurements are now made in situ using sensors and automatic readout or recording devices. Single and multi-parameter instruments are available for measuring temperature, depth, pH, oxidation-reduction potential (ORP), specific conductance, DO, some cations and anions, and light penetration.

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C.2.3 Estuaries

Estuarine areas are, by definition, zones where inland freshwaters (both surface and ground) mix with oceanic saline waters. Knowledge of the estuary type may be necessary to determine sampling locations. Estuaries are generally categorized into one of the following three types dependent on freshwater inflow and mixing properties:

- <u>Mixed Estuary</u> characterized by the absence of a vertical halocline (gradual or no marked increase
 in salinity in the water column) and a gradual increase in salinity seaward. Typically, this type of
 estuary is shallow and is found in major freshwater sheet flow areas. Because this type of estuary is
 well mixed, sampling locations are not critical.
- <u>Salt Wedge Estuary</u> characterized by a sharp vertical increase in salinity and stratified freshwater flow along the surface. In these estuaries, the vertical mixing forces cannot override the density differential between fresh and saline waters. In effect, a salt wedge tapering inland moves horizontally back and forth with the tidal phase. If contamination is being introduced into the estuary from upstream, water sampling from the salt wedge may miss it entirely.
- Oceanic Estuary characterized by salinities approaching full-strength oceanic waters. Seasonally, freshwater inflow is small, with the preponderance of the fresh-saline water mixing occurring near or at the shore line.

Sampling in estuarine areas is normally based on the tidal phase, with samples collected on successive slack tides (i.e., when the tide turns). Estuarine sampling programs shall include vertical salinity measurements at 1- to 5-foot increments, coupled with vertical DO and temperature profiles.



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Applicability

Tetra Tech NUS, Inc.

Prepared

Earth Sciences Department

Subject

SOIL SAMPLING

Approved

Tom Johnston



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1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the procedures to be used to collect surface, near-surface, and subsurface soil samples. Additionally, it describes the methods for sampling of test pits and trenches to determine subsurface soil and rock conditions and for recovery of small-volume or bulk samples from pits.

2.0 SCOPE

This document applies to the collection of surface, near-surface, and subsurface soil samples exposed through hand digging, hand augering, drilling, or machine excavating at hazardous substance sites for laboratory testing, onsite visual examination, and onsite testing.

3.0 GLOSSARY

<u>Composite Sample</u> - A composite sample is a combination of more than one grab sample from various locations and/or depths and times that is homogenized and treated as one sample. This type of sample is usually collected when determination of an average waste concentration for a specific area is required. Composite samples shall not be collected for volatile organics analysis.

Confined Space - As stipulated in 29 Code of Federal Regulations (CFR) 1910.146, a confined space means a space that: (1) is large enough and so configured that an employee can bodily enter and perform assigned work; (2) has limited or restricted means for entry or exit (e.g., tanks, vessels, silos, storage bins, hoppers, vaults, pits, and excavations); and (3) is not designed for continuous employee occupancy. TtNUS considers all confined space as permit-required confined spaces.

Grab Sample - One sample collected at one location and at one specific time.

Hand Auger - A sampling device used to extract soil from the ground.

Representativeness – A qualitative description of the degree to which an individual sample accurately reflects population characteristics or parameter variations at a sampling point. It is therefore an important characteristic not only of assessment and quantification of environmental threats posed by the site, but also for providing information for engineering design and construction. Proper sample location selection and proper sample collection methods are important to ensure that a truly representative sample has been collected.

<u>Sample for Non-Volatile Analyses</u> - Includes all chemical parameters other than volatile organics (e.g., semivolatiles, pesticides/PCBs, metals, etc.) and those engineering parameters that do not require undisturbed soil for their analysis.

<u>Split-Barrel Sampler</u> - A steel tube, split in half lengthwise, with the halves held together by threaded collars at either end of the tube. Also called a split-spoon sampler, this device can be driven into resistant materials using a drive weight mounted in the drilling string. A standard split-barrel sampler is typically available in two common lengths, providing either 20-inch or 26-inch longitudinal clearance for obtaining 18-inch or 24-inch-long samples, respectively. These split-barrel samplers commonly range in size from 2 to 3.5 inches OD. The larger sizes are commonly used when a larger volume of sample material is required (see Attachment B).

<u>Test Pit and Trench</u> - Open, shallow excavations, typically rectangular (if a test pit) or longitudinal (if a trench), excavated to determine shallow subsurface conditions for engineering, geological, and soil chemistry exploration and/or sampling purposes. These pits are excavated manually or by machine (e.g., backhoe, clamshell, trencher, excavator, or bulldozer).

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<u>Thin-Walled Tube Sampler</u> - A thin-walled metal tube (also called a Shelby tube) used to recover relatively undisturbed soil samples. These tubes are available in various sizes, ranging from 2 to 5 inches outside diameter (OD) and from 18 to 54 inches in length.

4.0 RESPONSIBILITIES AND PERSONNEL QUALIFICATIONS

<u>Project Manager</u> - The Project Manager is responsible for determining the sampling objectives, selecting proposed sampling locations, and selecting field procedures used in the collection of soil samples. Additionally, in consultation with other project personnel (geologist, hydrogeologist, etc.), the Project Manager establishes the need for test pits or trenches and determines their approximate locations and dimensions.

<u>Site Safety Officer (SSO)</u> - The SSO (or a qualified designee) is responsible for providing the technical support necessary to implement the project Health and Safety Plan. This will include (but not be limited to) performing air quality monitoring during sampling, boring, and excavation activities and to ensure that workers and offsite (downwind) individuals are not exposed to hazardous levels of airborne contaminants. The SSO/designee may also be required to advise the FOL on other safety-related matters regarding boring, excavation, and sampling, such as mitigative measures to address potential hazards from unstable trench walls, puncturing of drums or other hazardous objects, etc.

<u>Field Operations Leader (FOL)</u> - This individual is primarily responsible for the execution of the planning document containing the Sampling and Analysis Plan (SAP). This is accomplished through management of a field sampling team for the proper acquisition of samples. He or she is responsible for the supervision of onsite analyses; ensuring proper instrument calibration, care, and maintenance; sample collection and handling; the completion and accuracy of all field documentation; and making sure that custody of all samples obtained is maintained according to proper procedures. When appropriate and as directed by the FOL, such responsibilities may be performed by other qualified personnel (e.g., field technicians) where credentials and time permit. The FOL is responsible for finalizing the locations for collection of surface, near-surface, and subsurface (hand and machine borings, test pits/trenches) soil samples. He/she is ultimately responsible for the sampling and backfilling of boreholes, test pits, and trenches and for adherence to Occupational Safety and Health Administration (OSHA) regulations during these operations through self acquisition or through the management of a field team of samplers.

<u>Project Geologist/Sampler</u> - The project geologist/sampler is responsible for the proper acquisition of samples in accordance with this SOP and/or other project-specific documents. In addition, this individual is responsible for the completion of all required paperwork (e.g., sample log sheets, field notebook, boring logs, test pit logs, container labels, custody seals, and chain-of-custody forms) associated with the collection of those samples.

<u>Competent Person</u> - A Competent Person, as defined in 29 CFR 1929.650 of Subpart P - Excavations, means one who is capable of identifying existing and predictable hazards in the surroundings, or working conditions that are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them.

General personnel qualifications for groundwater sample collection and onsite water quality testing include the following:

- Occupational Safety and Health Administration (OSHA) 40-hour and applicable refresher training.
- Capability of performing field work under the expected physical and environmental (i.e., weather)
 conditions.

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• Familiarity with appropriate procedures for sample documentation, handling, packaging, and shipping.

5.0 HEALTH AND SAFETY

Health and safety precautions are identified for individual sample collection procedures throughout this SOP. In addition to those precautions, the following general hazards may be incurred during sampling activities:

- Knee injuries from kneeling on hard or uneven surfaces
- Slips, trips, and falls
- Cuts and lacerations
- Traffic hazards associated with sampling in parking areas, along roadways and highways.

Methods of avoiding these hazards are provided below.

Knee injuries – If kneeling is required during soil sampling, this could result in knee injuries from stones/foreign objects and general damage due to stress on the joints. To minimize this hazard:

- Clear any foreign objects from the work area.
- Wear hard-sided knee pads.
- Stretch ligaments, tendons and muscles before, during and after. Take breaks as frequently as necessary.
- Report pre-existing conditions to the SSO if you feel this activity will aggravate an existing condition.

Slips, Trips, and Falls – These hazards exist while traversing varying terrains carrying equipment to sample locations. To minimize these hazards:

- Pre-survey sampling locations. Eliminate, barricade, or otherwise mark physical hazards leading to the locations.
- Carry small loads that do not restrict the field of vision.
- Travel the safest and clearest route (not necessarily the shortest).

Cuts and Lacerations - To prevent cuts and lacerations associated with soil sampling, the following provisions are required:

- Always cut away from yourself and others when cutting tubing or rope. This will prevent injury to yourself and others if the knife slips.
- Do not place items to be cut in your hand or on your knee.
- Change blades as necessary to maintain a sharp cutting edge. Many accidents result from struggling with dull cutting attachments.

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- Whenever practical, wear cut-resistant gloves (e.g., leather or heavy cotton work gloves) at least on the hand not using the knife.
- Keep cutting surfaces clean and smooth.
- Secure items to be cut do not hold them against the opposing hand, a leg, or other body part.
- When transporting glassware, keep it in a hard-sided container such as a cooler so that if there is a fall, you will be less likely to get cut by broken glass.
- DO NOT throw broken sample jars or glass ampoules into garbage bags. Place broken glass and glass ampoules in hard-sided containers such as a cardboard box or directly into a dumpster. DO NOT reach into garbage bags to retrieve any item accidentally thrown away. Empty the contents onto a flat surface to avoid punctures and lacerations from reaching where you cannot see.

Vehicular and Foot Traffic Hazards – When sampling along the roadway or near traffic patterns, follow the following precautions:

- Motorists may be distracted by onsite activities ASSUME THEY DO NOT SEE YOU OR MEMBERS
 OF YOUR FIELD CREW.
- DO NOT place obstructions (such as vehicles) along the sides of the road that may cause site
 personnel to move into the flow of traffic to avoid your activities or equipment or that will create a
 blind spot.
- Provide a required free space of travel. Maintain at least 6 feet of space between you and moving traffic. Where this is not possible, use flaggers and/or signs to warn oncoming traffic of activities near or within the travel lanes.
- Face Traffic. Whenever feasible, if you must move within the 6 feet of the required free space or into traffic, attempt to face moving traffic at all times. Always leave yourself an escape route.
- Wear high-visibility vests to increase visual recognition by motorists.
- Do not rely on the vehicle operator's visibility, judgment, or ability. Make eye contact with the driver.
 Carefully and deliberately use hand signals so they will not startle or confuse motorists or be mistaken for a flagger's direction before moving into traffic.
- Your movements may startle a motorist and cause an accident, so move deliberately. Do not make sudden movements that might confuse a motorist.

6.0 PROCEDURES

The following procedures address surface and subsurface sampling.

CAUTION

Each situation must be evaluated individually to determine the applicability and necessity for obtaining a utility clearance ticket/dig permit. Common sense dictates, prior to digging or boring with power equipment, no matter what the depth, or digging by hand in a manner that could damage unprotected underground utilities, that a dig permit is required. See SOP HS-1.0, Utility Locating and Excavation Clearance, for additional clarification. If you do not know or are unsure as to whether a ticket is necessary – **Get**the **Ticket**.

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6.1 <u>Overview</u>

Soil sampling is an important adjunct to groundwater monitoring. Sampling of the soil horizons above the groundwater table can detect contaminants before they migrate to the water table, and can establish the amount of contamination absorbed or adsorbed on aquifer solids that have the potential of contributing to groundwater contamination.

Soil types can vary considerably on a hazardous waste site. These variations, along with vegetation, can affect the rate of contaminant migration through the soil. It is important, therefore, that a detailed record be maintained during sampling operations, particularly noting sampling locations, depths, and such characteristics as grain size, color, and odor. Subsurface conditions are often stable on a daily basis and may demonstrate only slight seasonal variation especially with respect to temperature, available oxygen and light penetration. Changes in any of these conditions can radically alter the rate of chemical reactions or the associated microbiological community, thus further altering specific site conditions. Certain vegetation species can create degradation products that can alter contaminant concentrations in soil. This is why vegetation types and extent of degradation of this foliage must be recorded. To prevent degradation, samples must be kept at their at-depth temperature or lower, protected from direct light, sealed tightly in approved glass containers, and be analyzed as soon as possible after collection. In addition, to the extent possible, vegetation should be removed from the sample.

The physical properties of the soil, its grain size, cohesiveness, associated moisture, and such factors as depth to bedrock and water table, will limit the depth from which samples can be collected and the method required to collect them. It is the intent of this document to present the most commonly employed soil sampling methods used at hazardous waste sites.

6.2 Soil Sample Collection

6.2.1 Procedure for Preserving and Collecting Soil Samples for Volatile Organic Compound Analysis

Samples collected using traditional methods such as collection in a jar with no preservation have been known to yield non-representative samples due to loss of volatile organic compounds (VOCs). To prevent such losses, preservation of samples with methanol or sodium bisulfate may be used to minimize volatilization and biodegradation. This preservation may be performed either in the field or laboratory, depending on the sampling methodology employed. Because of the large number of sampling methods and associated equipment required, careful coordination between field and laboratory personnel is needed.

Soil samples to be preserved by the laboratory are currently being collected using Method SW-846, 5035. For samples preserved in the field, laboratories are currently performing low-level analyses (sodium bisulfate preservation) and high- to medium-level analyses (methanol preservation) depending on the needs of the end user.

The following procedures outline the necessary steps for collecting soil samples to be preserved at the laboratory, and for collecting soil samples to be preserved in the field with methanol or sodium bisulfate.

6.2.1.1 Soil Samples to be Preserved at the Laboratory

Soil samples collected for volatile organic analysis that are to be preserved at the laboratory shall be obtained using a hermetically sealed sample vial such as an EnCore™ sampler. Each sample shall be

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obtained using a reusable sampling handle (T-handle) that can be provided with the EnCore™ sampler when requested and purchased. Collect the sample in the following manner for each EnCore™ sampler:

- 1. Scene Safety Evaluate the area where sampling will occur. Ensure that the area is safe from physical, chemical, and natural hazards. Clear or barricade those hazards that have been identified.
- 2. Wear the appropriate personal protective equipment (PPE). This will include, at a minimum, safety glasses and nitrile surgeon's gloves. If you must kneel on the ground or place equipment on the surface being sampled, cover the ground surface with plastic to minimize surface contamination of your equipment and clothing. Wear knee pads to protect your knees from kneeling on hard or uneven surfaces.
- 3. Load the Encore™ sampler into the T-handle with the plunger fully depressed.
- 4. Expose the area to be sampled using a hand trowel or similar device to remove surface debris.
- 5. Press the T-handle against the freshly exposed soil surface, forcing soil into the sampler. The plunger will be forced upward as the cavity fills with soil.
- 6. When the sampler is full, rotate the plunger and lock it into place. If the plunger does not lock, the sampler is not full. This method ensures there is no headspace. Soft soil may require several plunges or forcing soil against a hard surface such as a sample trowel to ensure that headspace is eliminated.
- 7. Use a paper towel to remove soil from the side of the sampler so a tight seal can be made between the sample cap and the rubber O-ring.
- 8. With soil slightly piled above the rim of the sampler, force the cap on until the catches hook the side of the sampler.
- 9. Remove any surface soil from the outside of the sampler and place in the foil bag provided with the sampler. Good work hygiene practices and diligent decontamination procedures prevents the spread of contamination even on the outside of the containers.
- 10. Label the bag with appropriate information in accordance with SOP SA-6.3.
- 11. Place the full sampler inside a lined cooler with ice and cool to 4°C ± 2°C. Make sure any required trip blanks and temperature blanks are also in the cooler. Secure custody of the cooler in accordance with SOP SA-6.3.
- 12. Typically, collect three Encore™ samplers at each location. Consult the SAP or laboratory to determine the required number of Encore™ samplers to be collected.
- 13. The T-handle shall be decontaminated before moving to the next interval or location using a soap and water wash and rinse, and where applicable, the selected solvent as defined in the project planning documents.

Using this type of sampling device eliminates the need for field preservation and the shipping restrictions associated with preservatives. A complete set of instructions is included with each Encore™ sampler.

After the Encore™samples are collected, they should be placed on ice immediately and delivered to the laboratory within 48 hours (following the chain-of-custody and documentation procedures outlined in SOP SA-6.1). Samples must be preserved by the laboratory within 48 hours of sample collection.

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6.2.1.2 <u>Soil Samples to be Preserved in the Field</u>

Soil samples preserved in the field may be prepared for analyses using both the low-level (sodium bisulfate preservation) and high- to medium-level (methanol preservation) methods.

Safety Reminder

When using chemicals in the field to preserve samples, the FOL and/or SSO must ensure that Materials Safety Data Sheets (MSDSs) have been provided with the chemicals to be used. They also must ensure that these chemicals have been added to the Chemical Inventory List contained within Section 5.0, Hazard Communication, of your Health and Safety Guidance Manual (HSGM). Lastly, but most importantly, the FOL and/or SSO must review the hazards with personnel using these chemicals and ensure that provisions are available for recommended PPE and emergency measures (e.g., eyewash, etc.).

Methanol Preservation (High to Medium Level):

Bottles may be pre-spiked with methanol in the laboratory or prepared in the field. Soil samples to be preserved in the field with methanol shall utilize 40 to 60 mL glass vials with septum-lined lids. Each sample bottle shall be filled with 25 mL of demonstrated analyte-free purge-and-trap grade methanol. The preferred method for adding methanol to the sample bottle is by removing the lid and using a pipette or scaled syringe to add the methanol directly to the bottle.

CAUTION

NEVER attempt to pipette by mouth

In situations where personnel are required to spike the septum using a hypodermic needle, the following provisions for handling sharps must be in place:

- Training of personnel regarding methods for handling of sharps
- Hard-sided containers for the disposal of sharps
- Provisions for treatment in cases where persons have received a puncture wound

Soil shall be collected with the use of a decontaminated (or disposable), small-diameter coring device such as a disposable tube/plunger-type syringe with the tip cut off. The outside diameter of the coring device must be smaller than the inside diameter of the sample bottle neck.

A small electronic balance or manual scale will be necessary for measuring the volume of soil to be added to the methanol-preserved sample bottle. Calibration of the scale shall be performed prior to use and intermittently throughout the day according to the manufacturer's requirements.

The sample should be collected as follows:

- 1. Weigh the unused syringe and plunger to the nearest 0.01 gram.
- 2. Pull the plunger back and insert the syringe into the soil to be sampled.
- 3. Collect 8 to 12 grams of soil by pushing the syringe barrel into the soil.
- 4. Weigh the sample and adjust until obtaining the required amount of sample.

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- Record the sample weight to the nearest 0.01 gram in the field logbook and/or on the sample log sheet.
- 6. Extrude the weighed soil sample into the methanol-preserved sample bottle taking care not to contact the sample container with the syringe.
- 7. If dirty, wipe soil particles from the threads of the bottle and cap. Cap the bottle tightly.
- 8. After capping the bottle, swirl the sample (do not shake) in the methanol and break up the soil such that all of the soil is covered with methanol.
- 9. Place the sample on ice immediately and prepare for shipment to the laboratory as described in SOP SA-6.1.

Sodium Bisulfate Preservation (Low Level):

CAUTION

Care should be taken when adding the soil to the sodium bisulfate solution. A chemical reaction of soil containing carbonates (limestone) may cause the sample to effervesce or the vial to possibly explode. To avoid this hazard or hazards of this type, a small sample aliquot should be subjected to the sample preservative. If it effervesces in an open air environment, utilize an alternative method such as Encore™ or 2-ounce jar.

Bottles may be prepared in the laboratory or in the field with sodium bisulfate solution. Samples to be preserved in the field using the sodium bisulfate method are to be prepared and collected as follows:

- 1. Add 1 gram of sodium bisulfate to 5 mL of laboratory-grade deionized water in a 40 to 60 mL glass vial with septum-lined lid.
- 2. Collect the soil sample and record the sample weight to the nearest 0.01 gram in the field logbook or on the sample log sheet as described for methanol preservation
- 3. Add the weighed sample to the sample vial.
- 4. Collect duplicate samples using the methanol preservation method on a one-for-one sample basis because it is necessary for the laboratory to perform both low-level and medium-level analyses.
- 5. Place the samples on ice immediately and prepare for shipment to the laboratory as described in SOP SA-6.1.

NOTE

If lower detection limits are necessary, an option to field preserving with sodium bisulfate may be to collect EnCore™ samplers at a given sample location. Consult the planning documents to determine whether this is required. If it is, collect samples in accordance with the Encore™ sampling procedure above and then send all samplers to the laboratory to perform the required preservation and analyses.

6.2.2 Procedure for Collecting Soil Samples for Non-Volatile Analyses

Samples collected for non-volatile analyses may be collected as either grab or composite samples as follows:

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- 1. With a stainless steel trowel or other approved tool, transfer a portion of soil to be sampled to a stainless steel bowl or disposable inert plastic tray.
- 2. Remove roots, vegetation, sticks, and stones larger than the size of a green pea.
- 3. Thoroughly mix the soil in the bowl or tray to obtain as uniform a texture and color as practicable. The soil type, moisture content, amount of vegetation, and other factors may affect the amount of time required to obtain a properly mixed sample. In some cases, it may be impossible to obtain a uniform sample appearance. Use the field logbook to describe any significant difficulties encountered in obtaining a uniform mixture.
- 4. Transfer the mixed soil to the appropriate sample containers and close the containers.
- 5. Label the sample containers in accordance with SOP SA-6.3.
- 6. Place the containers in a cooler of ice as soon after collection as possible.
- 7. Prepare the sample shipment and ship the samples in accordance with SOP SA-6.1.

NOTE

Cooling may not be required for some samples depending on the scheduled analyses. Consult the planning documents if in doubt regarding correct sample preservation conditions. When in doubt – Cool to 4°C.

NOTE

Head space is permitted in soil sample containers for non-volatile analyses to allow for sample expansion.

6.2.3 Procedure for Collecting Undisturbed Soil Samples

NOTE

Use of thin-walled undisturbed tube samplers is restricted by the consistency of the soil to be sampled. Often, very loose and/or wet samples cannot be retrieved by the samplers, and soil with a consistency in excess of very stiff cannot be penetrated by the sampler. Devices such as Dennison or Pitcher core samplers can be used to obtain undisturbed samples of stiff soil. Using these devices normally increases sampling costs, and therefore their use should be weighed against the need for acquiring an undisturbed sample. These devices are not discussed in this SOP because they are not commonly used.

When it is necessary to acquire undisturbed samples of soil for purposes of engineering parameter analysis (e.g., permeability), a thin-walled, seamless tube sampler (Shelby tube) shall be employed using the following collection procedure:

- 1. In preparation for sampling utilizing a drill rig, field personnel must complete the following activities:
 - Ensure that all subsurface drilling activities are preceded by a utility clearance for the area to be investigated. This includes activities described in SOP HS-1.0, Utility Location and Excavation Clearance, as well as any location-specific procedures that may apply.

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REMEMBER

If you are digging near a marked utility (within the diameter of an underground utility that has been marked plus 18 inches), you must first locate the utility through vacuum extraction or hand digging to ensure that your activities will not damage the utility.

- Complete an Equipment Inspection Checklist for the drill rig or direct-push technology (DPT) rig. This checklist will be provided in the HASP.
- Review the Safe Work Permit prior to conducting the activity.
- Review the activity to be conducted.
- 2. Remove all surface debris (e.g., vegetation, roots, twigs, etc.) from the specific sampling location and drill and/or clean out the borehole to the desired sampling depth. Be careful to minimize potential disturbance of the material to be sampled. In saturated material, withdraw the drill bit slowly to prevent loosening of the soil around the borehole and to maintain the water level in the hole at or above groundwater level.

CAUTION

The use of bottom-discharge bits or jetting through an open-tube sampler to clean out the borehole shall not be allowed. Only the use of side-discharge bits is permitted.

- 3. Determine whether a stationary piston-type sampler is required to limit sample disturbance and aid in retaining the sample. Either the hydraulically operated or control rod activated-type of stationary piston sampler may be used.
- 4. Prior to inserting the tube sampler into the borehole, check to ensure that the sampler head contains a check valve. The check valve is necessary to keep water in the rods from pushing the sample out the tube sampler during sample withdrawal. In addition, the check valve maintains a positive suction within the tube to help retain the sample.
- 5. A stainless steel tube sampler is typically used to minimize chemical reaction between the sample and the sampling tube.
- 6. With the sampling tube resting on the bottom of the hole and the water level in the boring at groundwater level or above, push the tube into the soil with a continuous and rapid motion, without impacting or twisting. If the soil is too hard to penetrate by pushing alone, careful hammering may be used by minimizing drop distance (tapping) of the hammer. Before pulling the tube, turn it at least one revolution to shear the sample off at the bottom. In no case shall the tube be pushed farther than the length provided for the soil sample. Allow about 3 inches in the tube for cuttings and sludge.
- 7. Upon removal of the sampling tube from the hole, measure the length of sample in the tube and also the length penetrated.
- 8. Remove disturbed material in the upper end of the tube and measure the length of sample again.
- 9. After removing at least 1 inch of soil from the lower end, place enough packing material (clean inert material such as paper or cloth) tightly in each end of the Shelby tube and then pour melted wax into each end to make at least a ½-inch wax plug and then add more packing material to fill the voids at both ends.

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- 10. Place plastic caps on the ends, tape the caps in place, and dip the ends in wax to prevent loss of soil.
- 11. Affix label(s) to the tube as required and record sample number, depth, penetration, and recovery length on the label.
- 12. Mark the "up" direction on the side and upper end of the tube with indelible ink.
- 13. Complete a chain-of-custody form (see SOP SA-6.3) and other required forms (including Attachment A of this SOP).
- 14. Ship samples protected with suitable resilient packing material to reduce shock, vibration, and disturbance.

CAUTION

To preserve sample integrity do not allow tubes to freeze, and store the samples vertically with the same orientation they had in the ground, (i.e., top of sample is up) in a cool place out of the sun at all times.

CAUTION

A primary concern in the preparation of the wax plugs is the potential for the heat source and melted wax to cause a fire and/or burns. Follow the directions below to prevent injury or fire.

Electrical Heating

Using hot plates to melt the wax is acceptable. In an outdoor setting, make sure a Ground Fault Circuit Interrupter (GFCI) is employed within the electrical circuit. If a portable generator is used, ensure that the generator is an adequate distance from the sampling operation (at least 50 feet). Ensure that the extension cord is rated for the intended load and for outdoor use and is free from recognizable damage. Ensure flammable preservatives are not employed or stored near the hot plate. Although a Hot Work Permit is not required, scene safety evaluation by site personnel of the above elements is. As always, if a fire potential exists, the provisions for extinguishing must be immediately accessible as well as any provisions for first aid measures.

Open Flame

If an open flame is used, the following provisions are necessary:

- Complete a Hot Work Permit and any local permit required for elevated temperature applications. The Hot Work Permit, provided in your HASP, will aid the FOL and/or the SSO in ensuring that fire protection provisions (extinguishers, fire watches, etc.) are in place as well as ensuring that local requirements have been addressed.
- Ensure that water is available to address any wax splashes or contact. If possible, immerse the contacted area. Where this is not possible, run water over the area and apply cold compresses. The need for medical attention or first aid shall be determined on site under the direction of the SSO.

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6.3 Surface Soil Sampling

The simplest, most direct method of collecting surface soil samples for subsequent analysis is by use of a stainless steel shovel, hand auger, soil corer, or stainless steel or disposable plastic trowel.

NOTE

Multiple depth intervals are used to describe surface soil. Sometimes surface soil is defined as soil from 0 to 2 inches below ground surface (bgs), and sometimes it is defined as soil from other depths such as 0 to 2 feet bgs. Ensure that the definition of surface soil depth is clear before collecting surface soil samples.

For the purposes of instruction, the terms "surface soil" and "near-surface soil" are used in this SOP as follows:

- Surface soil 0 to 6 inches bgs
- Near-surface soil 6 to 18 inches bgs

If these intervals are defined differently in the planning documents, substitute the appropriate depth ranges.

In general, the following equipment is necessary for obtaining surface soil samples:

- Stainless steel or pre-cleaned disposable trowel.
- Stainless steel hand auger, soil corer, or shovel.
- Real-time air monitoring instrument (e.g., PID, FID) as directed in project planning document.
- Required PPE.
 - Nitrile surgeon's or latex gloves may be used, layered as necessary.
 - Safety glasses
 - Other Items identified on the Safe Work Permit may be required based on location-specific requirements such as hearing protection, steel-toed work boots, and a hard hat when working near a drill rig. These provisions will be listed in the HASP or directed by the FOL and/or SSO.

Safety Reminder

The use of latex products may elicit an allergic reaction in some people. Should this occur, remove the latex gloves, treat for an allergic reaction, and seek medical attention as necessary.

- Required paperwork (see SOP SA-6.3 and Attachment A of this SOP)
- Required decontamination equipment
- Required sample container(s)
- Wooden stakes or pin flags

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- Sealable polyethylene bags (e.g., Ziploc® baggies)
- Heavy duty cooler
- Ice
- Chain-of-custody records and custody seals

When acquiring surface soil samples, use the following procedure:

- 1. Place padding or use knee pads when kneeling near the sample location. If necessary, place plastic sheeting to provide a clean surface for sample equipment to avoid possible cross- contamination.
- 2. Carefully remove vegetation, roots, twigs, litter, etc. to expose an adequate soil surface area to accommodate sample volume requirements.
- 3. Using a precleaned syringe or EnCoreTM samplers, follow the procedure in Section 6.2.1 for collecting surface soil samples for volatile analysis. Surface soil samples for volatile organic analysis should be collected deeper than 6 inches bgs because shallower material has usually lost most of the volatiles through evaporation. Ensure that the appropriate surface soil depth is being analyzed in accordance with the planning document.
- 4. Using decontaminated sampling tools, thoroughly mix in place a sufficient amount of soil to fill the remaining sample containers. See Section 6.5 of this procedure for hand auger instruction, as needed.
- 5. Transfer the sample into those containers utilizing a stainless steel trowel.
- 6. Cap and securely tighten all sample containers.
- 7. Affix a sample label to each container. Be sure to fill out each label carefully and clearly, addressing all the categories described in SOP SA-6.3.
- 8. Proceed with the handling and processing of each sample container as described in SOP SA-6.2.
- 9. Site restoration Whenever removing sample materials, always restore the surface. It is our intent to leave the area better than we found it. Do NOT create trip hazards in areas when pedestrian traffic may exist.

6.4 Near-Surface Soil Sampling

Collection of samples from near the surface (depth of 6 to 18 inches) can be accomplished with tools such as shovels, hand auger, soil corers, and stainless steel or pre-cleaned disposable trowels and the equipment listed under Section 6.5 of this procedure.

To obtain near-surface soil samples, the following protocol shall be used:

- 1. With a clean shovel, make a series of vertical cuts in the soil to the depth required to form a square approximately 1 foot by 1 foot.
- 2. Lever out the formed plug and scrape the bottom of the freshly dug hole with a decontaminated stainless steel or pre-cleaned disposable trowel to remove any loose soil.

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3. Follow steps 1 through 9 of Section 6.3.

6.5 Subsurface Soil Sampling With a Hand Auger

A hand augering system generally consists of a variety of stainless steel bucket bits (approximately 6.5 inches long and 2, 2.75, 3.25, and 4 inches in diameter), series of extension rods (available in 2-, 3-, 4- and 5-inch lengths), and a T-handle connected to extension rods and to the auger bucket. A larger-diameter bucket bit is commonly used to bore a hole to the desired sampling depth and then it is withdrawn. The larger-diameter bit is then replaced with a smaller-diameter bit, lowered down the hole, and slowly turned into the soil to the completion depth (approximately 6 inches). The apparatus is then withdrawn and the soil sample collected.

The hand auger can be used in a wide variety of soil conditions. It can be used to sample soil either from the surface, or to depths in excess of 12 feet. However, the presence of subsurface rocks and landfill material and collapse of the borehole normally limit sampling depth.

To accomplish soil sampling using a hand augering system, the following equipment is required:

- Complete hand auger assembly (variety of bucket bit sizes)
- Stainless steel mixing bowls
- The equipment listed in Section 6.3
- Miscellaneous hand tools as required to assemble and disassemble the hand auger units

CAUTION

Potential hazards associated with hand augering include:

- Muscle strain and sprain due to over twisting and/or over compromising yourself.
- Equipment failure due to excessive stress on the T-handle or rods through twisting. Failure of any of these components will result in a sudden release and potential injury due to that failure.

As in all situations, any intrusive activities that could damage underground utilities shall be proceeded by a Dig/Excavation permit/ticket. Call the Utility Locating service in the area or your Project Health and Safety Officer for more information. When in doubt – **Get the Ticket!**

To obtain soil samples using a hand auger, use the following procedure:

- 1. Wearing designated PPE, attach a properly decontaminated bucket bit to a clean extension rod and attach the T-handle to the extension rod.
- 2. Clear the area to be sampled of any surface debris (vegetation, twigs, rocks, litter, etc.).
- 3. Twist the bucket into the ground while pushing vertically downward on the auger. The cutting shoes fill the bucket as it is advanced into the ground.
- 4. As the auger bucket fills with soil, periodically remove any unneeded soil.

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- 5. Add rod extensions as necessary to extend the reach of the auger. Also, note (in a field notebook, boring log, and/or on a standardized data sheet) any changes in the color, texture or odor of the soil as a function of depth. The project-specific planning document (SAP, HASP, etc.) describe requirements for scanning the soil with a real-time air monitoring instrument (e.g., PID, FID, etc.) and recording the measurements.
- 6. After reaching the desired depth (e.g., the top of the interval to be sampled), slowly and carefully withdraw the apparatus from the borehole to prevent or minimize movement of soil from shallower intervals to the bottom of the hole.
- 7. Remove the soiled bucket bit from the rod extension and replace it with another properly decontaminated bucket bit. The bucket bit used for sampling is to be smaller in diameter than the bucket bit employed to initiate the borehole.
- 8. Carefully lower the apparatus down the borehole. Care must be taken to avoid scraping the borehole sides.
- 9. Slowly turn the apparatus until the bucket bit is advanced approximately 6 inches.
- 10. Discard the top of the core (approximately 1 inch), which represents any loose material collected by the bucket bit before penetrating the sample material.
- 11. Using a precleaned syringe or EnCore[™] samplers, follow the procedure in Section 6.2.1 for collecting a soil sample for volatile compound analysis directly from the bucket bit.
- 12. Utilizing a properly decontaminated stainless steel trowel or dedicated disposable trowel, remove the remaining sample material from the bucket bit and place into a properly decontaminated stainless steel mixing bowl.
- 13. Homogenize the sample material as thoroughly as practicable then fill the remaining sample containers. Refer to Section 6.2.2.
- 14. Follow steps 4 through 7 listed in Section 6.3.

6.5.1 Sampling Using Stainless Steel Soil Corers

A soil corer is a stainless steel tube equipped with a cutting shoe and sample window in the side. The soil corer is advanced into the soil by applying downward pressure (body weight). The soil is unloaded by then forcing a ram towards the cutting shoe, which results in the discharge of the soil core through a window in the sleeve.

Use, application, and sample protocol is the same as for hand augering provided above, but without necessarily rotating the corer while advancing it.

SAFETY REMINDER

Hand augering and soil corer sampling can be physically demanding based on the type of geology and subsurface encumbrances encountered. Soil coring has some added hazards such the corer collapsing under your weight. To reduce the potential for muscle strain and damage, the following measures will be incorporated:

- Stretch and limber your muscles before heavy exertion. This hazard becomes more predominant in the early morning hours (prior to muscles becoming limber) and later in the day (as a result of fatigue).

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- Job rotation Share the duties so that repetitive actions do not result in fatigue and injury.
- Increase break frequencies as needed, especially as ambient conditions of heat and/or cold stress may dictate.
- Do not force the hand tools or use cheater pipes or similar devices to bypass an obstruction. Move to another location near the sampling point. Exerting additional forces on the sampling devices can result in damage and/or failure that could potentially injure someone in the immediate vicinity.
- Do not over compromise yourself when applying force to the soil corer or hand auger. If there is a sudden release, it could result in a fall or muscle injury due to strain.

6.6 <u>Subsurface Soil Sampling with a Split-Barrel Sampler</u>

A split-barrel (split-spoon) sampler consists of a heavy carbon steel or stainless steel sampling tube that can be split into two equal halves to reveal the soil sample (see Attachment B). A drive head is attached to the upper end of the tube and serves as a point of attachment for the drill rod. A removable tapered nosepiece/drive shoe attaches to the lower end of the tube and facilitates cutting. A basket-like sample retainer can be fitted to the lower end of the split tube to hold loose, dry soil samples in the tube when the sampler is removed from the drill hole. This split-barrel sampler is made to be attached to a drill rod and forced into the ground by means of a 140-pound or larger casing driver.

Safety Reminder

It is intended through the Equipment Inspection for Drill Rigs form provided in the HASP that the hammer and hemp rope, where applicable, associated with this activity will be inspected (no physical damage is obvious), properly attached to the hammer (suitable knots or sufficient mechanical devices), and is in overall good condition.

Split-barrel samplers are used to collect soil samples from a wide variety of soil types and from depths greater than those attainable with other soil sampling equipment.

The following equipment is used for obtaining split-barrel samples:

- Drilling equipment (provided by subcontractor).
- Split-barrel samplers (2-inch OD, 1-3/8-inch ID, either 20 inches or 26 inches long); Larger OD samplers are available if a larger volume of sample is needed.
- Drive weight assembly, 140-pound weight, driving head, and guide permitting free fall of 30 inches.
- Stainless steel mixing bowls.
- Equipment listed in Section 6.3.

The following steps shall be followed to obtain split-barrel samples (Steps 1 through 4 are typically performed by the drilling subcontractor):

1. Attach the split-barrel sampler to the sampling rods.

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- 2. Lower the sampler into the borehole inside the hollow stem auger bits.
- 3. Advance the split-barrel sampler by hammering the length (typically 18 or 24 inches) of the split-barrel sampler into the soil using 140-pound or larger hammer.
- 4. When the desired depth is achieved, extract the drill rods and sampler from the augers and/or borehole.
- 5. Detach the sampler from the drill rods.
- 6. Place the sampler securely in a vise so it can be opened using pipe wrenches.

CAUTION

Pipe wrenches are used to separate the split spoon into several components. The driller's helper should not apply excessive force through the use of cheater pipes or push or pull in the direction where, if the wrench slips, hands or fingers will be trapped against an immovable object.

- 7. Remove the drive head and nosepiece with the wrenches, and open the sampler to reveal the soil sample.
- 8. Immediately scan the sample core with a real-time air monitoring instrument (e.g., FID, PID, etc.) (as project-specific planning documents dictate). Carefully separate (or cut) the soil core, with a decontaminated stainless steel knife or trowel, at about 6-inch intervals while scanning the center of the core for elevated readings. Also scan stained soil, soil lenses, and anomalies (if present), and record readings.
- 9. If elevated vapor readings were observed, collect the sample scheduled for volatile analysis from the center of the core where elevated readings occurred. If no elevated readings where encountered, the sample material should be collected from the core's center (this area represents the least disturbed area with minimal atmospheric contact) (refer to Section 6.2.1).
- 10. Using the same trowel, remove remaining sample material from the split-barrel sampler (except for the small portion of disturbed soil usually found at the top of the core sample) and place the soil into a decontaminated stainless steel mixing bowl.
- 11. Homogenize the sample material as thoroughly as practicable then fill the remaining sample containers (refer to Section 6.2.2).
- 12. Follow steps 4 through 7 in Section 6.3.

6.7 <u>Subsurface Soil Sampling Using Direct-Push Technology</u>

Subsurface soil samples can be collected to depths of 40+ feet using DPT. DPT equipment, responsibilities, and procedures are described in SOP SA-2.5.

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6.8 <u>Excavation and Sampling of Test Pits and Trenches</u>

6.8.1 Applicability

This subsection presents routine test pit or trench excavation techniques and specialized techniques that are applicable under certain conditions.

CAUTION

During the excavation of trenches or pits at hazardous waste sites, several health and safety concerns arise from the method of excavation. No personnel shall enter any test pit or excavation over 4 feet deep except as a last resort, and then only under direct supervision of a Competent Person (as defined in 29 CFR 1929.650 of Subpart P -Excavations). Whenever possible, all required chemical and lithological samples should be collected using the excavator bucket or other remote sampling apparatus. If entrance is required, all test pits or excavations must be stabilized by bracing the pit sides using specifically designed wooden, steel, or aluminum support structures or through sloping and benching. Personnel entering the excavation may be exposed to toxic or explosive gases and oxygen-deficient environments; therefore, monitoring will be conducted by the Competent Person to determine if it is safe to enter. Any entry into a trench greater than 4 feet deep will constitute a Confined Space Entry and must be conducted in conformance with OSHA standard 29 CFR 1910.146. In all cases involving entry, substantial air monitoring, before entry, appropriate respiratory gear and protective clothing determination, and rescue provisions are mandatory. There must be at least three people present at the immediate site before entry by one of the field team members. This minimum number of people will increase based on the potential hazards or complexity of the work to be performed. The reader shall refer to OSHA regulations 29 CFR 1926.650, 29 CFR 1910.120, 29 CFR 1910.134, and 29 CFR 1910.146. Highhazard entries such as this will be supported by members of the Health Sciences Group professionally trained in these activities.

Excavations are generally not practical where a depth of more than about 15 to 20-feet is desired, and they are usually limited to a few feet below the water table. In some cases, a pumping system may be required to control water levels within the pit, providing that pumped water can be adequately stored or disposed. If soil data at depths greater than 15-feet are required, the data are usually obtained through test borings instead of test pits.

In addition, hazardous wastes may be brought to the surface by excavation equipment. This material, whether removed from the site or returned to the subsurface, must be properly handled according to any and all applicable federal, state, and local regulations.

6.8.2 Test Pit and Trench Excavation

Test pits or trench excavations are constructed with the intent that they will provide an open view of subsurface lithology and/or disposal conditions that a boring will not provide. These procedures describe the methods for excavating and logging test pits and trenches installed to determine subsurface soil and rock conditions. Test pit operations shall be logged and documented (see Attachment C).

Test pits and trenches may be excavated by hand or power equipment to permit detailed descriptions of the nature and contamination of the in-situ materials. The size of the excavation will depend primarily on the following:

• The purpose and extent of the exploration

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- The space required for efficient excavation
- The chemicals of concern
- The economics and efficiency of available equipment

Test pits normally have a cross section that is 4 to 10 feet square; test trenches are usually 3 to 6 feet wide and may be extended for any length required to reveal conditions along a specific line. The following table provides guidelines for design consideration based on equipment efficiencies.

Equipment	Typical Widths, in Feet
Trenching machine	0.25 to 1.0
Backhoe/Track Hoe	2 to 6

The lateral limits of excavation of trenches and the position of test pits shall be carefully marked on area base maps. If precise positioning is required to indicate the location of highly hazardous materials, nearby utilities, or dangerous conditions, the limits of the excavation shall be surveyed. Also, if precise determination of the depth of buried materials is needed for design or environmental assessment purposes, the elevation of the ground surface at the test pit or trench location shall also be determined by survey. If the test pit/trench will not be surveyed immediately, it shall be backfilled and its position identified with stakes placed in the ground at the margin of the excavation for later surveying.

The construction of test pits and trenches shall be planned and designed in advance as much as possible. However, the following field conditions may necessitate revisions to the initial plans:

- Subsurface utilities
- Surface and subsurface encumbrances
- Vehicle and pedestrian traffic patterns
- Purpose for excavation (e.g., the excavation of potential ordnance items)

The final depth and construction method shall be collectively determined by the FOL and designated Competent Person. The actual layout of each test pit, temporary staging area, and spoils pile may further be predicated based on site conditions and wind direction at the time the test pit is excavated. Prior to excavation, the area may be surveyed by magnetometer or metal detector or other passive methods specified in SOP HS1.0, Utility Location and Excavation Clearance, to identify the presence of underground utilities or drums. Where possible, the excavator should be positioned upwind and preferably within an enclosed cab.

No personnel shall enter any test pit or excavation except as a last resort, and then only under direct supervision of a Competent Person. If entrance is required, OSHA requirements must be met (e.g., walls must be braced with wooden or steel braces, ladders must be placed for every 25 feet of lateral travel and extended 3 feet above ground surface). A temporary guard rail or vehicle stop must be placed along the surface of the hole before entry in situations where the excavation may be approached by traffic. Spoils will be stockpiled no closer than 2 feet from the sidewall of the excavation. The excavation equipment operator shall be careful not to undercut sidewalls and will, where necessary, bench back to increase stability. The top cover, when considered clean, will be placed separately from the subsurface materials to permit clean cover. It is emphasized that the project data needs should be structured such that required samples can be collected without requiring entrance into the excavation. For example,

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samples of leachate, groundwater, or sidewall soil can be collected with telescoping poles or similar equipment.

Dewatering and watering may be required to ensure the stability of the side walls, to prevent the bottom of the pit from heaving, and to keep the excavation stable. This is an important consideration for excavations in cohesionless material below the groundwater table and for excavations left open greater than a day. Liquids removed as a result of dewatering operations must be handled as potentially contaminated materials. Procedures for the collection and disposal of such materials should be discussed in the site-specific project plans.

Where possible excavations and test pits shall be opened and closed within the same working day. Where this is not possible, the following engineering controls shall be put in place to control access:

- Trench covers/street plates
- Fences encompassing the entire excavation intended to control access
- Warning signs warning personnel of the hazards
- Amber flashing lights to demarcate boundaries of the excavation at night

Excavations left open will have emergency means to exit should someone accidentally enter.

6.8.3 Sampling in Test Pits and Trenches

6.8.3.1 General

Log test pits and trenches as they are excavated in accordance with the Test Pit Log presented in Attachment C. These records include plan and profile sketches of the test pit/trench showing materials encountered, their depth and distribution in the pit/trench, and sample locations. These records also include safety and sample screening information.

Entry of test pits by personnel is extremely dangerous, shall be avoided unless absolutely necessary, and can occur only after all applicable health and safety and OSHA requirements have been met as stated above. These provisions will be reiterated as appropriate in the project-specific HASP.

The final depth and type of samples obtained from each test pit will be determined at the time the test pit is excavated. Sufficient samples are usually obtained and analyzed to quantify contaminant distribution as a function of depth for each test pit. Additional samples of each waste phase and any fluids encountered in each test pit may also be collected.

In some cases, samples of soil may be extracted from the test pit for reasons other than waste sampling and chemical analysis, for instance, to obtain geotechnical information. Such information includes soil types, stratigraphy, strength, etc., and could therefore entail the collection of disturbed (grab or bulk) or relatively undisturbed (hand-carved or pushed/driven) samples that can be tested for geotechnical properties. The purposes of such explorations are very similar to those of shallow exploratory or test borings, but often test pits offer a faster, more cost-effective method of sampling than installing borings.

6.8.3.2 <u>Sampling Equipment</u>

The following equipment is needed for obtaining samples for chemical or geotechnical analysis from test pits and trenches:

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- Backhoe or other excavating machinery.
- Shovels, picks, hand augers, and stainless steel trowels/disposable trowels.
- Sample container bucket with locking lid for large samples; appropriate bottle ware for chemical or geotechnical analysis samples.
- Polyethylene bags for enclosing sample containers; buckets.
- Remote sampler consisting of 10-foot sections of steel conduit (1-inch-diameter), hose clamps, and right angle adapter for conduit (see Attachment D).

6.8.3.3 Sampling Methods

The methods discussed in this section refer to test pit sampling from grade level. If test pit entry is required, see Section 6.8.3.4.

- Excavate the trench or pit in several 0.5- to 1.0-foot depth increments. Where soil types support the use of a sand bar cutting plate, use of this device is recommended to avoid potentially snagging utilities with the excavator teeth. It is recommended that soil probes or similar devices be employed where buried items or utilities may be encountered. This permits the trench floor to be probed prior to the next cut.
- After each increment:
 - the operator shall wait while the sampler inspects the test pit from grade level
 - the sampler shall probe the next interval where this is considered necessary. Practical depth increments for lithological evaluations may range from 2 to 4 feet i or where lithological changes are noted.
- The backhoe operator, who will have the best view of the test pit, shall immediately cease digging if:
 - Any fluid phase, including groundwater seepage, is encountered in the test pit
 - Any drums, other potential waste containers, obstructions, or utility lines are encountered
 - Distinct changes of material being excavated are encountered

This action is necessary to permit proper sampling of the test pit and to prevent a breach of safety protocol. Depending on the conditions encountered, it may be required to excavate more slowly and carefully with the backhoe.

For obtaining test pit samples from grade level, the following procedure shall be followed:

- Use the backhoe to remove loose material from the excavation walls and floor to the greatest extent possible.
- Secure the walls of the pit, if necessary. (There is seldom any need to enter a pit or trench that would justify the expense of shoring the walls. All observations and samples should be taken from the ground surface.)

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- Samples of the test pit material are to be obtained either directly from the backhoe bucket or from the material after it has been deposited on the ground, as follows:
 - a. The sampler or FOL shall direct the backhoe operator to remove material from the selected depth or location within the test pit/trench.
 - b. The backhoe operator shall bring the bucket over to a designated location on the sidewall a sufficient distance from the pit (at least 5 feet) to allow the sampler to work around the bucket.
 - c. After the bucket has been set on the ground, the backhoe operator shall either disengage the controls or shut the machine down.
 - d. When signaled by the operator that it is safe to do, the sampler will approach the bucket.
 - e. The soil shall be monitored with a photoionization or flame ionization detector (PID or FID) as directed in the project -specific planning documents.
 - f. The sampler shall collect the sample from the center of the bucket or pile in accordance with surface soil sampling procedures of Section 6.3 or 6.4, as applicable. Collecting samples from the center of a pile or bucket eliminates cross-contamination from the bucket or other depth intervals.
- If a composite sample is desired, several depths or locations within the pit/trench will be selected, and the bucket will be filled from each area. It is preferable to send individual sample bottles filled from each bucket to the laboratory for compositing under the more controlled laboratory conditions. However, if compositing in the field is required, each sample container shall be filled from materials that have been transferred into a mixing bucket and homogenized. Note that homogenization/compositing is not applicable for samples to be subjected to volatile organic analysis.

CAUTION

Care must be exercised when using the remote sampler described in the next step because of potential instability of trench walls. In situations where someone must move closer than 2 feet to the excavation edge, a board or platform should be used to displace the sampler's weight to minimize the chance of collapse of the excavation edge. Fall protection should also be employed when working near the edges or trenches greater than 6 feet deep. An immediate means to extract people who have fallen into the trench will be immediately available. These means may include ladders or rope anchor points.

- Using the remote sampler shown in Attachment D, samples can be taken at the desired depth from the sidewall or bottom of the pit as follows:
 - a. Scrape the face of the pit/trench using a long-handled shovel or hoe to remove the smeared zone that has contacted the backhoe bucket.
 - b. Collect the sample directly into the sample jar, by scraping with the jar edge, eliminating the need for sample handling equipment and minimizing the likelihood of cross-contamination.
 - c. Cap the sample jar, remove it from the remote sampler assembly, and package the sample for shipment in accordance with SOP SA-6.3.
- Complete documentation as described in SOP SA-6.3 and Attachment C of this SOP.

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6.8.3.4 <u>In-Pit Sampling</u>

Under rare conditions, personnel may be required to enter the test pit/trench. This is necessary only when soil conditions preclude obtaining suitable samples from the backhoe bucket (e.g., excessive mixing of soil or wastes within the test pit/trench) or when samples from relatively small discrete zones within the test pit are required. This approach may also be necessary to sample any seepage occurring at discrete levels or zones in the test pit that are not accessible with remote samplers.

In general, personnel shall sample and log pits and trenches from the ground surface, except as provided for by the following criteria:

- There are no practical alternative means of obtaining such data.
- The SSO and Competent Person determine that such action can be accomplished without breaching site safety protocol. This determination will be based on actual monitoring of the pit/trench after it is dug (including, at a minimum, measurements of oxygen concentration, flammable gases, and toxic compounds, in that order). Action levels will be provided in project-specific planning documents.
- A company-designated Competent Person determines that the pit/trench is stable trough soil
 classification evaluation/inspections or is made stable (by cutting/grading the sidewalls or using
 shoring) prior to entrance of any personnel. OSHA requirements shall be strictly observed.

If these conditions are satisfied, only one person may enter the pit/trench. On potentially hazardous waste sites, this individual shall be dressed in selected PPE as required by the conditions in the pit. He/she shall be affixed to a harness and lifeline and continuously monitored while in the pit.

A second and possible third individual shall be fully dressed in protective clothing including a self-contained breathing device and on standby during all pit entry operations to support self rescue or assisted self rescue. The individual entering the pit shall remain therein for as brief a period as practical, commensurate with performance of his/her work. After removing the smeared zone, samples shall be obtained with a decontaminated trowel or spoon.

6.8.3.5 Geotechnical Sampling

In addition to the equipment described in Section 6.8.3.2, the following equipment is needed for geotechnical sampling:

- Soil sampling equipment, similar to that used in shallow drilled boring (i.e., thin-walled tube samplers), that can be pushed or driven into the floor of the test pit.
- Suitable driving (e,g., sledge hammer) or pushing (e.g., backhoe bucket) equipment used to advance the sampler into the soil.
- Knives, spatulas, and other suitable devices for trimming hand-carved samples.
- Suitable containers (bags, jars, tubes, boxes, etc.), labels, wax, etc. for holding and safely transporting collected soil samples.
- Geotechnical equipment (pocket penetrometer, torvane, etc.) for field testing collected soil samples for classification and strength properties.

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Disturbed grab or bulk geotechnical soil samples may be collected for most soil in the same manner as comparable soil samples for chemical analysis. These collected samples may be stored in jars or plastic-lined sacks (larger samples), which will preserve their moisture content. Smaller samples of this type are usually tested for their index properties to aid in soil identification and classification: larger bulk samples are usually required to perform compaction tests.

Relatively undisturbed samples are usually extracted in cohesive soil using thin-walled tube samplers, and such samples are then tested in a geotechnical laboratory for their strength, permeability, and/or compressibility. The techniques for extracting and preserving such samples are similar to those used in performing Shelby tube sampling in borings, except that the sampler is advanced by hand or backhoe, rather than by a drill rig. Also, the sampler may be extracted from the test pit by excavation around the tube when it is difficult to pull it out of the ground. If this excavation requires entry of the test pit, the requirements described in Section 6.8.3.4 shall be followed. The thin-walled tube sampler shall be pushed or driven vertically into the floor or steps excavated in the test pit at the desired sampling elevations. Extracting tube samples horizontally from the walls of the test pit is not appropriate because the sample will not have the correct orientation.

A sledge hammer or backhoe may be used to drive or push the tube into the ground. Place a piece of wood over the top of the sampler or sampling tube to prevent damage during driving/pushing of the sample. Pushing the sampler with a constant thrust is always preferable to driving it with repeated blows, thus minimizing disturbance to the sample. When using a sledge hammer, it is recommended that the sampler be stabilized using a rope/strap wrench or pipe wrench to remove the person's hands holding the sampler from the strike zone. If the sample cannot be extracted by rotating it at least two revolutions (to shear off the sample at the bottom), hook the sampler to the excavator or backhoe and extract. This means an alternative head will be used as a connection point or that multiple choke hitches will be applied to extract the sampler. If this fails and the excavator can dig deeper without potentially impacting subsurface utilities, excavate the sampler. If this fails or if the excavator cannot be used due to subsurface utilities, hand-excavate to remove the soil from around the sides of the sampler. If hand-excavation requires entry into the test pit, the requirements in Section 6.8.3.4 must be followed. Prepare the sample as described in Steps 9 through 13 in Section 6.2.3, and label, pack and transport the sample in the required manner, as described in SOPs SA-6.3 and SA-6.1.

6.8.4 Backfilling of Trenches and Test Pits

All test pits and excavations must be either backfilled, covered, or otherwise protected at the end of each day. No excavations shall remain open during non-working hours unless adequately covered or otherwise protected.

Before backfilling, the onsite crew may photograph, if required by the project-specific work plan, all significant features exposed by the test pit and trench and shall include in the photograph a scale to show dimensions. Photographs of test pits shall be marked to include site number, test pit number, depth, description of feature, and date of photograph. In addition, a geologic description of each photograph shall be entered in the site logbook. All photographs shall be indexed and maintained as part of the project file for future reference.

After inspection, backfill material shall be returned to the pit under the direction of the FOL. Backfill should be returned to the trench or test pit in 6-inch to 1-foot lifts and compacted with the bucket. Remote controlled tampers or rollers may be lowered into the trench and operated from top side. This procedure will continue to the grade surface. It is recommended that the trench be tracked or rolled in. During excavation, clean soil from the top 2 feet may have been separated to be used to cover the last segments. Where these materials are not clean, it is recommended that clean fill be used for the top cover.

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If a low-permeability layer is penetrated (resulting in groundwater flow from an upper contaminated flow zone into a lower uncontaminated flow zone), backfill material must represent original conditions or be impermeable. Backfill could consist of a soil-bentonite mix prepared in a proportion specified by the FOL (representing a permeability equal to or less than original conditions). Backfill can be covered by "clean" soil and graded to the original land contour. Revegetation of the disturbed area may also be required.

6.9 Records

The appropriate sample log sheet (see Attachment A of this SOP) must be completed by the site geologist/sampler for all samples collected. All soil sampling locations should be documented by tying in the location of two or more nearby permanent landmarks (building, telephone pole, fence, etc.) or obtaining GPS coordinates; and shall be noted on the appropriate sample log sheet, site map, or field notebook. Surveying may also be necessary, depending on the project requirements.

Test pit logs (see Attachment C of this SOP) shall contain a sketch of pit conditions. If the project-specific work plan requires photographs, at least one photograph with a scale for comparison shall be taken of each pit. Included in the photograph shall be a card showing the test pit number. Boreholes, test pits, and trenches shall be logged by the field geologist in accordance with SOP GH-1.5.

Other data to be recorded in the field logbook include the following:

- Name and location of job
- Date of boring and excavation
- Approximate surface elevation
- Total depth of boring and excavation
- Dimensions of pit
- Method of sample acquisition
- Type and size of samples
- Soil and rock descriptions
- Photographs if required
- Groundwater levels
- PID/FID/LEL/O₂ meter readings
- Other pertinent information, such as waste material encountered

In addition, site-specific documentation to be maintained by the SSO and/or Competent Person will be required including:

- Calibration logs
- Excavation inspection checklists

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• Soil type classification

7.0 REFERENCES

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NUS Corporation, 1986. Hazardous Material Handling Training Manual.

NUS Corporation and CH2M Hill, August, 1987. Compendium of Field Operation Methods. Prepared for the U.S. EPA.

OSHA, Excavation, Trenching and Shoring 29 CFR 1926.650-653.

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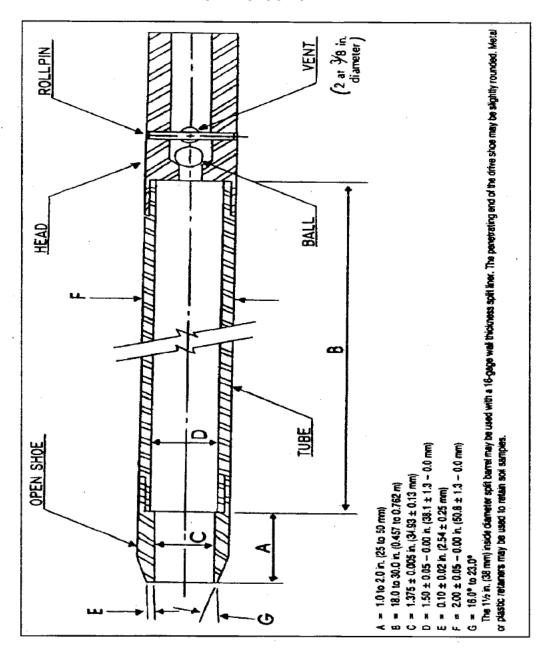
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ATTACHMENT A SOIL & SEDIMENT SAMPLE LOG SHEET

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Project Site Nai Project No.:	_			Sample II Sample L Sampled	ocation: By:	Page_	of
[] Surface So [] Subsurface [] Sediment [] Other: [] QA Sampl	e Soil				_		
GRAB SAMPLE DAT	TA:		t by #10 c				
Date:		Depth	Color	Description	(Sand, Silt,	Clay, Moist	ure, etc.)
Time:							
Method:				-			
Monitor Reading (pp	m):						
COMPOSITE SAMP	LE DATA:		7/4 9				
Date:	Time	Depth	Color	Description	n (Sand, Silt,	Clay, Moist	ure, etc.)
Method:							
Monitor Readings							
(Range in ppm):							
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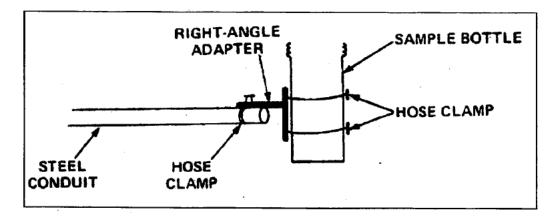
ATTACHMENT B SPLIT-SPOON SAMPLER



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				ATTACHMENT (TEST PIT LOG	•			
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		ECT NAME:		TE	ST PIT N	o.:		
	LOCA	ECT NUMBER TION:	:	GE	TE: OLOGIS	Г:		
	Depth (Ft.)	Lithology Change (Depth/Ft.)	Soil/Was	te Characteristics density, color, etc.)	U S C	Remarks	PID/FID F	EADING (wdd) Zg
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ATTACHMENT D REMOTE SAMPLE HOLDER FOR TEST PIT/TRENCH SAMPLING





TETRA TECH NUS, INC.

STANDARD OPERATING PROCEDURES

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Applicability

Tetra Tech NUS, Inc.

Prepared

Earth Sciences Department

Approved

D. Senovich

Subject

NON-RADIOLOGICAL SAMPLE HANDLING

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1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide information on sample preservation, packaging, and shipping procedures to be used in handling environmental samples submitted for chemical constituent, biological, or geotechnical analysis. Sample chain-of-custody procedures and other aspects of field documentation are addressed in SOP SA-6.3. Sample identification is addressed in SOP CT-04.

2.0 SCOPE

This procedure describes the appropriate containers to be used for samples depending on the analyses to be performed, and the steps necessary to preserve the samples when shipped off site for chemical analysis.

3.0 GLOSSARY

<u>Hazardous Material</u> - A substance or material which has been determined by the Secretary of Transportation to be capable of posing an unreasonable risk to health, safety, and property when transported in commerce, and which has been so designated. Under 49 CFR, the term includes hazardous substances, hazardous wastes, marine pollutants, and elevated temperature materials, as well as materials designated as hazardous under the provisions of §172.101 and §172.102 and materials that meet the defining criteria for hazard classes and divisions in Part 173. With slight modifications, IATA has adopted DOT "hazardous materials" as IATA "Dangerous Goods."

Hazardous Waste - Any substance listed in 40 CFR, Subpart D (y261.30 et seq.), or otherwise characterized as ignitable, corrosive, reactive, or toxic (as defined by Toxicity Characteristic Leaching Procedure, TCLP, analysis) as specified under 40 CFR, Subpart C (y261.20 et seq.), that would be subject to manifest requirements specified in 40 CFR 262. Such substances are defined and regulated by EPA.

Marking - A descriptive name, identification number, instructions, cautions, weight, specification or UN marks, or combination thereof required on outer packaging of hazardous materials.

n.o.i - Not otherwise indicated (may be used interchangeably with n.o.s.).

n.o.s. - Not otherwise specified.

<u>Packaging</u> - A receptacle and any other components or materials necessary for compliance with the minimum packaging requirements of 49 CFR 174, including containers (other than freight containers or overpacks), portable tanks, cargo tanks, tank cars, and multi-unit tank-car tanks to perform a containment function in conformance with the minimum packaging requirements of 49 CFR 173.24(a) & (b).

<u>Placard</u> - Color-coded, pictorial sign which depicts the hazard class symbol and name and which is placed on the side of a vehicle transporting certain hazardous materials.

Common Preservatives:

- Hydrochloric Acid HCl
- Sulfuric Acid H₂SO₄
- Nitric Acid HNO₃
- Sodium Hydroxide NaOH

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Other Preservatives

- Zinc Acetate
- Sodium Thiosulfate Na₂S₂O₃

Normality (N) - Concentration of a solution expressed as equivalent per liter, an equivalent being the amount of a substance containing 1 gram-atom of replaceable hydrogen or its equivalent.

Reportable Quantity (RQ) - For the purposes of this SOP, means the quantity specified in column 3 of the Appendix to DOT 49 CFR §172.101 for any material identified in column 1 of the appendix. A spill greater than the amount specified must be reported to the National Response Center.

<u>Sample</u> - A sample is physical evidence collected from a facility or the environment, which is representative of conditions at the location and time of collection.

4.0 RESPONSIBILITIES

<u>Field Operations Leader</u> - Directly responsible for the bottling, preservation, labeling, packaging, shipping, and custody of samples up to and including release to the shipper.

<u>Field Samplers</u> - Responsible for initiating the Chain-of-Custody Record (per SOP SA-6.3), implementing the packaging and shipping requirements, and maintaining custody of samples until they are relinquished to another custodian or to the shipper.

5.0 PROCEDURES

Sample identification, labeling, documentation, and chain-of-custody are addressed by SOP SA-6.3.

5.1 Sample Containers

Different types of chemicals react differently with sample containers made of various materials. For example, trace metals adsorb more strongly to glass than to plastic, whereas many organic chemicals may dissolve various types of plastic containers. Attachments A and B show proper containers (as well as other information) per 40 CFR 136. In general, the sample container shall allow approximately 5-10 percent air space ("ullage") to allow for expansion/vaporization if the sample warms during transport. However, for collection of volatile organic compounds, head space shall be omitted. The analytical laboratory will generally provide certified-clean containers for samples to be analyzed for chemical constituents. Shelby tubes or other sample containers are generally provided by the driller for samples requiring geotechnical analysis. Sufficient lead time shall be allowed for a delivery of sample container orders. Therefore, it is critical to use the correct container to maintain the integrity of the sample prior to analysis.

Once opened, the container must be used at once for storage of a particular sample. Unused but opened containers are to be considered contaminated and must be discarded. Because of the potential for introduction of contamination, they cannot be reclosed and saved for later use. Likewise, any unused containers which appear contaminated upon receipt, or which are found to have loose caps or a missing Teflon liner (if required for the container), shall be discarded.

5.2 Sample Preservation

Many water and soil samples are unstable and therefore require preservation to prevent changes in either the concentration or the physical condition of the constituent(s) requiring analysis. Although complete and irreversible preservation of samples is not possible, preservation does retard the chemical and biological

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changes that inevitably take place after the sample is collected. Preservation techniques are usually limited to pH control, chemical addition(s), and refrigeration/ freezing (certain biological samples only).

5.2.1 Overview

The preservation techniques to be used for various analytes are listed in Attachments A and B. Reagents required for sample preservation will either be added to the sample containers by the laboratory prior to their shipment to the field or be added in the field (in a clean environment). Only high purity reagents shall be used for preservation. In general, aqueous samples of low-concentration organics (or soil samples of low- or medium-concentration organics) are cooled to 4°C. Medium-concentration aqueous samples, high-hazard organic samples, and some gas samples are typically not preserved. Low-concentration aqueous samples for metals are acidified with HNO₃, whereas medium-concentration and high-hazard aqueous metal samples are not preserved. Low- or medium-concentration soil samples for metals are cooled to 4°C, whereas high-hazard samples are not cooled.

The following subsections describe the procedures for preparing and adding chemical preservatives. Attachments A and B indicate the specific analytes which require these preservatives.

The FOL is responsible for ensuring that an accurate Chemical Inventory is created and maintained for all hazardous chemicals brought to the work site (see Section 5 of the TtNUS Health and Safety Guidance Manual). Furthermore, the FOL must ensure that a corresponding Material Safety Data Sheet (MSDS) is collected for every substance entered on the site Chemical Inventory, and that all persons using/handling/disposing of these substances review the appropriate MSDS for substances they will work with. The Chemical Inventory and the MSDSs must be maintained at each work site in a location and manner where they are readily-accessible to all personnel.

5.2.2 Preparation and Addition of Reagents

Addition of the following acids or bases may be specified for sample preservation; these reagents shall be analytical reagent (AR) grade or purer and shall be diluted to the required concentration with deionized water before field sampling commences. To avoid uncontrolled reactions, be sure to Add Acid to water (not vice versa). A dilutions guide is provided below.

Acid/Base	Dilution Concentration		Estimated Amount Required for Preservation	
Hydrochloric Acid (HCI)	1 part concentrated HCI: 1 part double-distilled, deionized water	6N	5-10 mL	
Sulfuric Acid (H ₂ SO ₄)	1 part concentrated H ₂ SO ₄ : 1 part double-distilled, deionized water	18N	2 - 5 mL	
Nitric Acid (HNO ₃)	Undiluted concentrated HNO ₃	16N	2 - 5 mL	
Sodium Hydroxide (NaOH)	400 grams solid NaOH dissolved in 870 mL double-distilled, deionized water; yields 1 liter of solution	10N	2 mL	

The amounts required for preservation shown in the above table assumes proper preparation of the preservative and addition of the preservative to one liter of aqueous sample. This assumes that the sample is initially at pH 7, is poorly buffered, and does not contain particulate matter; as these conditions vary, more preservative may be required. Consequently, the final sample pH must be checked using narrow-range pH paper, as described in the generalized procedure detailed below:

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- Pour off 5-10 mL of sample into a dedicated, clean container. Use some of this sample to check the
 initial sample pH using wide range (0-14) pH paper. Never dip the pH paper into the sample; always
 apply a drop of sample to the pH paper using a clean stirring rod or pipette.
- Add about one-half of the estimated preservative required to the original sample bottle. Cap and invert gently several times to mix. Check pH (as described above) using medium range pH paper (pH 0-6 or pH 7.5-14, as applicable).
- Cap sample bottle and seal securely.

Additional considerations are discussed below:

To test if ascorbic acid must be used to remove oxidizing agents present in the sample before it can
be properly preserved, place a drop of sample on KI-starch paper. A blue color indicates the need for
ascorbic acid addition.

If required, add a few crystals of ascorbic acid to the sample and retest with the KI-starch paper. Repeat until a drop of sample produces no color on the KI-starch paper. Then add an additional 0.6 grams of ascorbic acid per each liter of sample volume.

Continue with proper base preservation of the sample as described above.

 Samples for sulfide analysis must be treated by the addition of 4 drops (0.2 mL) of 2N zinc acetate solution per 100 ml of sample.

The 2N zinc acetate solution is made by dissolving 220 grams of zinc acetate in 870 mL of double-distilled, deionized water to make 1 liter of solution.

The sample pH is then raised to 9 using the NaOH preservative.

 Sodium thiosulfate must be added to remove residual chlorine from a sample. To test the sample for residual chlorine use a field test kit specially made for this purpose.

If residual chlorine is present, add 0.08 grams of sodium thiosulfate per liter of sample to remove the residual chlorine.

Continue with proper acidification of the sample as described above.

For biological samples, 10% buffered formalin or isopropanol may also be required for preservation. Questions regarding preservation requirements should be resolved through communication with the laboratory <u>before</u> sampling begins.

5.3 Field Filtration

At times, field-filtration may be required to provide for the analysis of dissolved chemical constituents. Field-filtration must be performed <u>prior to</u> the preservation of samples as described above. General procedures for field filtration are described below:

The sample shall be filtered through a non-metallic, 0.45-micron membrane filter, immediately after
collection. The filtration system shall consist of dedicated filter canister, dedicated tubing, and a
peristaltic pump with pressure or vacuum pumping squeeze action (since the sample is filtered by
mechanical peristalsis, the sample travels only through the tubing).

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- To perform filtration, thread the tubing through the peristaltic pump head. Attach the filter canister to
 the discharge end of the silicon tubing (note flow direction arrow); attach the aqueous sample
 container to the intake end of the silicon tubing. Turn the peristaltic pump on and perform filtration.
 Run approximately 100 ml of sample through the filter and discard prior to sample collection.
- Continue by preserving the filtrate (contained in the filter canister), as applicable and generally described above.

5.4 Sample Packaging and Shipping

Only employees who have successfully completed the TtNUS "Shipping Hazardous Materials" training course are authorized to package and ship hazardous substances. These trained individuals are responsible for performing shipping duties in accordance with this training.

Samples collected for shipment from a site shall be classified as either <u>environmental</u> or <u>hazardous</u> <u>material samples</u>. Samples from drums containing materials other than Investigative Derived Waste (IDW) and samples obtained from waste piles or bulk storage tanks are generally shipped as hazardous materials. A distinction must be made between the two types of samples in order to:

- Determine appropriate procedures for transportation of samples (if there is any doubt, a sample shall be considered hazardous and shipped accordingly.)
- Protect the health and safety of transport and laboratory personnel receiving the samples (special
 precautions are used by the shipper and at laboratories when hazardous materials are received.)

Detailed procedures for packaging environmental samples are outlined in the remainder of this section.

5.4.1 Environmental Samples

Environmental samples are packaged as follows:

- Place properly identified sample container, with lid securely fastened, in a plastic bag (e.g. Ziploc baggie), and seal the bag.
- Place sample in a cooler constructed of sturdy material which has been lined with a large, plastic bag (e.g. "garbage" bag). Drain plugs on coolers must be taped shut.
- Pack with enough cushioning materials such as bubble wrap (shoulders of bottles must be iced if required) to minimize the possibility of the container breaking.
- If cooling is required (see Attachments A and B), place ice around sample container shoulders, and on top of packing material (minimum of 8 pounds of ice for a medium-size cooler).
- Seal (i.e., tape or tie top in knot) large liner bag.
- The original (top, signed copy) of the COC form shall be placed inside a large Ziploc-type bag and taped inside the lid of the shipping cooler. If multiple coolers are sent but are included on one COC form, the COC form should be sent with the cooler containing the vials for VOC analysis. The COC form should then state how many coolers are included with that shipment.
- Close and seal outside of cooler as described in SOP SA-6.3. Signed custody seals must be used.

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Coolers must be marked as containing "Environmental Samples." The appropriate side of the container must be marked "This End Up" and arrows placed appropriately. No DOT marking or labeling is required; there are no DOT restrictions on mode of transportation.

6.0 REFERENCES

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ATTACHMENT A

GENERAL SAMPLE CONTAINER AND PRESERVATION REQUIREMENTS

Sample Type and Concentration		Container ⁽¹⁾	Sample Size	Preservation ⁽²⁾	Holding Time ⁽²⁾
WATER			4		
Organics (GC&GC/MS)	VOC Low	Borosilicate glass	2 x 40 mL	Cool to 4°C HCl to ≤ 2	14 days ⁽⁹⁾
	Extractables (Low SVOCs and pesticide/PCBs)	Amber glass	2x2 L or 4x1 L	Cool to 4°C	7 days to extraction; 40 days after extraction
	Extractables (Medium SVOCs and pesticide/PCBs)	Amber glass	2x2 L or 4x1 L	None	7 days to extraction; 40 days after extraction
Inorganics	Metals Low	High-density polyethylene	1L	HNO ₃ to pH ≤2	6 months (Hg-28 days)
	Medium	Wide-mouth glass	16 oz.	None	6 months
	Cyanide Low	High-density polyethylene	11	NaOH to pH>12	14 days
	Cyanide Medium	Wide-mouth glass	16 oz.	None	14 days
Organic/ Inorganic	High Hazard	Wide-mouth glass	8 oz.	None	14 days
SOIL					
Organics (GC&GC/MS)	voc	EnCore Sampler	(3) 5 g Samplers	Cool to 4°C	48 hours to lab preservation
	Extractables (Low SVOCs and pesticides/PCBs)	Wide-mouth glass	8 oz.	Cool to 4°C	14 days to extraction; 40 days after extraction
	Extractables (Medium SVOCs and pesticides/PCBs)	Wide-mouth glass	8 oz.	Cool to 4°C	14 days to extraction; 40 days after extraction
Inorganics	Low/Medium	Wide-mouth glass	8 oz.	Cool to 4°C	6 months (Hg - 28 days) Cyanide (14 days)
Organic/Inorga nic	High Hazard	Wide-mouth glass	8 oz.	None	NA
Dioxin/Furan	All	Wide-mouth glass	4 oz.	None	35 days until extraction; 40 days after extraction
TCLP	Ali	Wide-mouth glass	8 oz.	None	7 days until preparation, analysis as per fraction
AIR					1
Volatile Organics	Low/Medium	Charcoal tube - 7 cm long, 6 mm OD, 4 mm ID	100 L air	Cool to 4°C	5 days recommended

All glass containers should have Teflon cap liners or septa. See Attachment E. Preservation and maximum holding time allowances per 40 CFR 136.

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ATTACHMENT B

ADDITIONAL REQUIRED CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES

Parameter Number/Name	Container ⁽¹⁾	Preservation ⁽²⁾⁽³⁾	Maximum Holding Time ⁽⁴⁾
INORGANIC TESTS:			
Acidity	P, G	Cool, 4°C	14 days
Alkalinity	P, G	Cool, 4°C	14 days
Ammonia - Nitrogen	P, G	Cool, 4°C; H ₂ SO ₄ to pH 2	28 days
Biochemical Oxygen Demand (BOD)	P, G	Cool, 4°C	48 hours
Bromide	P, G	None required	28 days
Chemical Oxygen Demand (COD)	P, G	Cool, 4°C; H₂SO₄ to pH 2	28 days
Chloride	P, G	None required	28 days
Chlorine, Total Residual	P, G	None required	Analyze immediately
Color	P, G	Cool, 4°C	48 hours
Cyanide, Total and Amenable to Chlorination	P, G	Cool, 4°C; NaOH to pH 12; 0.6 g ascorbic acid ⁽⁵⁾	14 days ⁽⁶⁾
Fluoride	Р	None required	28 days
Hardness	P, G	HNO ₃ to pH 2; H ₂ SO ₄ to pH 2	6 months
Total Kjeldahl and Organic Nitrogen	P, G	Cool, 4°C; H ₂ SO ₄ to pH 2	28 days
Nitrate - Nitrogen	P, G	None required	48 hours
Nitrate-Nitrite - Nitrogen	P, G	Cool, 4°C; H ₂ SO ₄ to pH 2	28 days
Nitrite - Nitrogen	P, G	Cool, 4°C	48 hours
Oil & Grease	G	Cool, 4°C; H ₂ SO ₄ to pH 2	28 days
Total Organic Carbon (TOC)	P, G	Cool, 4°C; HCl or H ₂ SO ₄ to pH 2	28 days
Orthophosphate	P, G	Filter immediately; Cool, 4°C	48 hours
Oxygen, Dissolved-Probe	G Bottle & top	None required	Analyze immediately
Oxygen, Dissolved-Winkler	G Bottle & top	Fix on site and store in dark	8 hours
Phenois	G	Cool, 4°C; H ₂ SO ₄ to pH 2	28 days
Phosphorus, Total	P, G	Cool, 4°C; H ₂ SO ₄ to pH 2	28 days
Residue, Total	P, G	Cool, 4°C	7 days
Residue, Filterable (TDS)	P, G	Cool, 4°C	7 days
Residue, Nonfilterable (TSS)	P, G	Cool, 4°C	7 days
Residue, Settleable	P, G	Cool, 4°C	48 hours
Residue, Volatile (Ash Content)	P, G	Cool, 4°C	7 days
Silica	Р	Cool, 4°C	28 days
Specific Conductance	P, G	Cool, 4°C	28 days
Sulfate	P, G	Cool, 4°C	28 days

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ATTACHMENT B ADDITIONAL REQUIRED CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES PAGE TWO

Parameter Number/Name	Container ⁽¹⁾	Preservation ⁽²⁾⁽³⁾	Maximum Holding Time ⁽⁴⁾
INORGANIC TESTS (Cont'd):			
Sulfide	P, G	Cool, 4°C; add zinc acetate plus sodium hydroxide to pH 9	7 days
Sulfite	P, G	None required	Analyze immediately
Turbidity	P, G	Cool, 4°C	48 hours
METALS:(7)			
Chromium VI (Hexachrome)	P, G	Cool, 4°C	24 hours
Mercury (Hg)	P, G	HNO₃ to pH 2	28 days
Metals, except Chromium VI and Mercury	P, G	HNO ₃ to pH 2	6 months
ORGANIC TESTS:(8)			
Purgeable Halocarbons	G, Teflon-lined septum	Cool, 4°C; 0.008% Na ₂ S ₂ O ₃ ⁽⁵⁾	14 days
Purgeable Aromatic Hydrocarbons	G, Teflon-lined septum	Cool, 4°C; 0.008% Na₂S₂O₃ ⁽⁵⁾ HCl to pH 2 ⁽⁹⁾	14 days
Acrolein and Acrylonitrile	G, Teflon-lined septum	Cool, 4°C; 0.008% Na ₂ S ₂ O ₃ ⁽⁵⁾ adjust pH to 4-5 ⁽¹⁰⁾	14 days
Phenois ⁽¹¹⁾	G, Teflon-lined cap	Cool, 4°C; 0.008% Na ₂ S ₂ O ₃ (5)	7 days until extraction 40 days after extraction
Benzidines ^{(11), (12)}	G, Teflon-lined cap	Cool, 4°C; 0.008% Na ₂ S ₂ O ₃ ⁽⁵⁾	7 days until extraction ⁽¹³⁾
Phthalate esters ⁽¹¹⁾	G, Teflon-lined cap	Cool, 4°C	7 days until extraction 40 days after extraction
Nitrosamines(11),(14)	G, Teflon-lined cap	Cool, 4°C; store in dark; 0.008% Na ₂ S ₂ O ₃ ⁽⁵⁾	7 days until extraction 40 days after extraction
PCBs ⁽¹¹⁾	G, Teflon-lined cap	Cool, 4°C	7 days until extraction 40 days after extraction
Nitroaromatics & Isophorone ⁽¹¹⁾	G, Teflon-lined cap	Cool, 4°C; 0.008% Na ₂ S ₂ O ₃ ⁽⁵⁾ ; store in dark	7 days until extraction 40 days after extraction
Polynuclear Aromatic Hydrocarbons (PAHs) ⁽¹¹⁾ ,(14)	G, Teflon-lined cap	Cool, 4°C; 0.008% Na ₂ S ₂ O ₃ ⁽⁵⁾ ; store in dark	7 days until extraction 40 days after extraction
Haloethers ⁽¹¹⁾	G, Teflon-lined cap	Cool, 4°C; 0.008% Na ₂ S ₂ O ₃ ⁽⁵⁾	7 days until extraction 40 days after extraction
Dioxin/Furan (TCDD/TCDF) ⁽¹¹⁾	G, Teflon-lined cap	Cool, 4°C; 0.008% Na ₂ S ₂ O ₃ ⁽⁵⁾	7 days until extraction 40 days after extraction

Subject NON-RADIOLOGICAL SAMPLE HANDLING	Number SA-6.1	Page 11 of 11
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ATTACHMENT B ADDITIONAL REQUIRED CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES PAGE THREE

(1) Polyethylene (P): generally 500 ml or Glass (G): generally 1L.

Sample preservation should be performed immediately upon sample collection. For composite chemical samples each aliquot should be preserved at the time of collection. When use of an automated sampler makes it impossible to preserve each aliquot, then chemical samples may be preserved by maintaining at 4°C until compositing and sample splitting is completed.

(3) When any sample is to be shipped by common carrier or sent through the United States Mail, it must comply with the Department of Transportation Hazardous Materials Regulations (49 CFR Part 172).

Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis and still be considered valid. Samples may be held for longer periods only if the permittee, or monitoring laboratory, has data on file to show that the specific types of samples under study are stable for the longer periods, and has received a variance from the Regional Administrator.

(5) Should only be used in the presence of residual chlorine.

(6) Maximum holding time is 24 hours when sulfide is present. Optionally, all samples may be tested with lead acetate paper before pH adjustments are made to determine if sulfide is present. If sulfide is present, it can be removed by the addition of cadmium nitrate powder until a negative spot test is obtained. The sample is filtered and then NaOH is added to pH 12.

Samples should be filtered immediately on site before adding preservative for dissolved metals.

Guidance applies to samples to be analyzed by GC, LC, or GC/MS for specific compounds.

(9) Sample receiving no pH adjustment must be analyzed within 7 days of sampling.

(10) The pH adjustment is not required if acrolein will not be measured. Samples for acrolein receiving no pH adjustment must

be analyzed within 3 days of sampling.

- (11) When the extractable analytes of concern tall within a single chemical category, the specified preservative and maximum holding times should be observed for optimum safeguard of sample integrity. When the analytes of concern fall within two or more chemical categories, the sample may be preserved by cooling to 4°C, reducing residual chlorine with 0.008% sodium thiosulfate, storing in the dark, and adjusting the pH to 6-9; samples preserved in this manner may be held for 7 days before extraction and for 40 days after extraction. Exceptions to this optional preservation and holding time procedure are noted in footnote 5 (re: the requirement for thiosulfate reduction of residual chlorine) and footnotes 12, 13 (re: the analysis of benzidine).
- (12) If 1,2-diphenylthydrazine is likely to be present, adjust the pH of the sample to 4.0±0.2 to prevent rearrangement to benzidine.
- (13) Extracts may be stored up to 7 days before analysis if storage is conducted under an inert (oxidant-free) atmosphere.
- (14) For the analysis of diphenylnitrosamine, add 0.008% Na₂S₂O₃ and adjust pH to 7-10 with NaOH within 24 hours of
- (15) The pH adjustment may be performed upon receipt at the laboratory and may be omitted if the samples are extracted... within 72 hours of collection. For the analysis of aldrin, add 0.008% Na₂S₂O₃.



TETRA TECH NUS, INC.

STANDARD OPERATING PROCEDURES

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Applicability

Tetra Tech NUS, Inc.

Prepared

Earth Sciences Department

Approved D. Senovich

Subject

FIELD DOCUMENTATION

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1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to identify and designate the field data record forms, logs and reports generally initiated and maintained for documenting Tetra Tech NUS field activities.

2.0 SCOPE

Documents presented within this procedure (or equivalents) shall be used for all Tetra Tech NUS field activities, as applicable. Other or additional documents may be required by specific client contracts or project planning documents.

3.0 GLOSSARY

None

4.0 RESPONSIBILITIES

<u>Project Manager (PM)</u> - The Project Manager is responsible for obtaining hardbound, controlled-distribution logbooks (from the appropriate source), as needed. In addition, the Project Manager is responsible for placing all field documentation used in site activities (i.e., records, field reports, sample data sheets, field notebooks, and the site logbook) in the project's central file upon the completion of field work.

<u>Field Operations Leader (FOL)</u> - The Field Operations Leader is responsible for ensuring that the site logbook, notebooks, and all appropriate and current forms and field reports illustrated in this guideline (and any additional forms required by the contract) are correctly used, accurately filled out, and completed in the required time-frame.

5.0 PROCEDURES

5.1 Site Logbook

5.1.1 General

The site logbook is a hard-bound, paginated, controlled-distribution record book in which all major onsite activities are documented. At a minimum, the following activities/events shall be recorded or referenced (daily) in the site logbook:

- · All field personnel present
- Arrival/departure of site visitors
- Time and date of H&S training
- Arrival/departure of equipment
- Time and date of equipment calibration
- Start and/or completion of borehole, trench, monitoring well installation, etc.
- Daily onsite activities performed each day
- · Sample pickup information
- Health and Safety issues (level of protection observed, etc.)
- · Weather conditions

A site logbook shall be maintained for each project. The site logbook shall be initiated at the start of the first onsite activity (e.g., site visit or initial reconnaissance survey). Entries are to be made for every day

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that onsite activities take place which involve Tetra Tech NUS or subcontractor personnel. Upon completion of the fieldwork, the site logbook must become part of the project's central file.

The following information must be recorded on the cover of each site logbook:

- Project name
- · Tetra Tech NUS project number
- · Sequential book number
- Start date
- End date

Information recorded daily in the site logbook need not be duplicated in other field notebooks (see Section 5.2), but must summarize the contents of these other notebooks and refer to specific page locations in these notebooks for detailed information (where applicable). An example of a typical site logbook entry is shown in Attachment A.

If measurements are made at any location, the measurements and equipment used must either be recorded in the site logbook or reference must be made to the field notebook in which the measurements are recorded (see Attachment A).

All logbook, notebook, and log sheet entries shall be made in indelible ink (black pen is preferred). No erasures are permitted. If an incorrect entry is made, the entry shall be crossed out with a single strike mark, and initialed and dated. At the completion of entries by any individual, the logbook pages used must be signed and dated. The site logbook must also be signed by the Field Operations Leader at the end of each day.

5.1.2 Photographs

When movies, slides, or photographs are taken of a site or any monitoring location, they must be numbered sequentially to correspond to logbook/notebook entries. The name of the photographer, date, time, site location, site description, and weather conditions must be entered in the logbook/notebook as the photographs are taken. A series entry may be used for rapid-sequence photographs. The photographer is not required to record the aperture settings and shutter speeds for photographs taken within the normal automatic exposure range. However, special lenses, films, filters, and other image-enhancement techniques must be noted in the logbook/notebook. If possible, such techniques shall be avoided, since they can adversely affect the accuracy of photographs. Chain-of-custody procedures depend upon the subject matter, type of camera (digital or film), and the processing it requires. Film used for aerial photography, confidential information, or criminal investigation require chain-of-custody procedures. Once processed, the slides of photographic prints shall be consecutively numbered and labeled according to the logbook/notebook descriptions. The site photographs and associated negatives and/or digitally saved images to compact disks must be docketed into the project's central file.

5.2 Field Notebooks

Key field team personnel may maintain a separate dedicated field notebook to document the pertinent field activities conducted directly under their supervision. For example, on large projects with multiple investigative sites and varying operating conditions, the Health and Safety Officer may elect to maintain a separate field notebook. Where several drill rigs are in operation simultaneously, each site geologist assigned to oversee a rig must maintain a field notebook.

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5.3 Field Forms

All Tetra Tech NUS field forms (see list in Section 6.0 of this SOP) can be found on the company's intranet site (http://intranet.ttnus.com) under Field Log Sheets. Forms may be altered or revised for project-specific needs contingent upon client approval. Care must be taken to ensure that all essential information can be documented. Guidelines for completing these forms can be found in the related sampling SOP.

5.3.1 Sample Collection, Labeling, Shipment, Request for Analysis, and Field Test Results

5.3.1.1 Sample Log Sheet

Sample Log Sheets are used to record specified types of data while sampling. The data recorded on these sheets are useful in describing the sample as well as pointing out any problems, difficulties, or irregularities encountered during sampling. A log sheet must be completed for each sample obtained, including field quality control (QC) samples.

5.3.1.2 Sample Label

A typical sample label is illustrated in Attachment B. Adhesive labels must be completed and applied to every sample container. Sample labels can usually be obtained from the appropriate Program source electronically generated in-house, or are supplied from the laboratory subcontractor.

5.3.1.3 Chain-of-Custody Record Form

The Chain-of-Custody (COC) Record is a multi-part form that is initiated as samples are acquired and accompanies a sample (or group of samples) as they are transferred from person to person. This form must be used for any samples collected for chemical or geotechnical analysis whether the analyses are performed on site or off site. One carbonless copy of the completed COC form is retained by the field crew, one copy is sent to the Project Manager (or designee), while the original is sent to the laboratory. The original (top, signed copy) of the COC form shall be placed inside a large Ziploc-type bag and taped inside the lid of the shipping cooler. If multiple coolers are sent but are included on one COC form, the COC form should be sent with the cooler containing vials for VOC analysis or the cooler with the air bill attached. The air bill should then state how many coolers are included with that shipment. An example of a Chain-of-Custody Record form is provided as Attachment C. Once the samples are received at the laboratory, the sample cooler and contents are checked and any problems are noted on the enclosed COC form (any discrepancies between the sample labels and COC form and any other problems that are noted are resolved through communication between the laboratory point-of-contact and the Tetra Tech NUS Project Manager). The COC form is signed and copied. The laboratory will retain the copy while the original becomes part of the samples' corresponding analytical data package.

5.3.1.4 Chain-of-Custody Seal

Attachment D is an example of a custody seal. The Custody seal is an adhesive-backed label. It is part of a chain-of-custody process and is used to prevent tampering with samples after they have been collected in the field and sealed in coolers for transport to the laboratory. The COC seals are signed and dated by the sampler(s) and affixed across the lid and body of each cooler (front and back) containing environmental samples (see SOP SA-6.1). COC seals may be available from the laboratory; these seals may also be purchased from a supplier.

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5.3.1.5 Geochemical Parameters Log Sheets

Field Analytical Log Sheets are used to record geochemical and/or natural attenuation field test results.

5.3.2 Hydrogeological and Geotechnical Forms

5.3.2.1 Groundwater Level Measurement Sheet

A Groundwater Level Measurement Sheet must be filled out for each round of water level measurements made at a site.

5.3.2.2 Data Sheet for Pumping Test

During the performance of a pumping test (or an in-situ hydraulic conductivity test), a large amount of data must be recorded, often within a short time period. The Pumping Test Data Sheet facilitates this task by standardizing the data collection format for the pumping well and observation wells, and allowing the time interval for collection to be laid out in advance.

5.3.2.3 Packer Test Report Form

A Packer Test Report Form must be completed for each well upon which a packer test is conducted.

5.3.2.4 Boring Log

During the progress of each boring, a log of the materials encountered, operation and driving of casing, and location of samples must be kept. The Summary Log of Boring, or Boring Log is used for this purpose and must be completed for each soil boring performed. In addition, if volatile organics are monitored on cores, samples, cuttings from the borehole, or breathing zone, (using a PID or FID), these readings must be entered on the boring log at the appropriate depth. The "Remarks" column can be used to subsequently enter the laboratory sample number, the concentration of key analytical results, or other pertinent information. This feature allows direct comparison of contaminant concentrations with soil characteristics.

5.3.2.5 Monitoring Well Construction Details Form

A Monitoring Well Construction Details Form must be completed for every monitoring well, piezometer, or temporary well point installed. This form contains specific information on length and type of well riser pipe and screen, backfill, filter pack, annular seal and grout characteristics, and surface seal characteristics. This information is important in evaluating the performance of the monitoring well, particularly in areas where water levels show temporal variation, or where there are multiple (immiscible) phases of contaminants. Depending on the type of monitoring well (in overburden or bedrock, stick-up or flush mount), different forms are used.

5.3.2.6 Test Pit Log

When a test pit or trench is constructed for investigative or sampling purposes, a Test Pit Log must be filled out by the responsible field geologist or sampling technician.

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5.3.2.7 Miscellaneous Monitoring Well Forms

Monitoring Well Materials Certificate of Conformance should be used as the project directs to document all materials utilized during each monitoring well installation.

The Monitoring Well Development Record should be used as the project directs to document all well development activities.

5.3,2.8 Miscellaneous Field Forms - QA and Checklists

Container Sample and Inspection Sheet should be used as the project directs each time a container (drum, tank, etc.) is sampled and/or inspected.

QA Sample Log Sheet should be used at the project directs each time a QA sample is colleted, such as Rinsate Blank, Source Blank, etc.

Field Task Modification Request (FTMR) will be prepared for all deviations from the project planning documents. The FOL is responsible for initiating the FTMRs. Copies of all FTMRs will be maintained with the onsite planning documents and originals will be placed in the final evidence file.

The Field Project Daily Activities Check List and Field Project Pre-Mobilization Checklist should be used during both the planning and field effort to assure that all necessary tasks are planned for and completed. These two forms are not a requirement but a useful tool for most field work.

5.3.3 Equipment Calibration and Maintenance Form

The calibration or standardization of monitoring, measuring or test equipment is necessary to assure the proper operation and response of the equipment, to document the accuracy, precision or sensitivity of the measurement, and determine if correction should be applied to the readings. Some items of equipment require frequent calibration, others infrequent. Some are calibrated by the manufacturer, others by the user.

Each instrument requiring calibration has its own Equipment Calibration Log which documents that the manufacturer's instructions were followed for calibration of the equipment, including frequency and type of standard or calibration device. An Equipment Calibration Log must be maintained for each electronic measuring device used in the field; entries must be made for each day the equipment is used or in accordance with the manufacturer's recommendations.

5.4 Field Reports

The primary means of recording onsite activities is the site logbook. Other field notebooks may also be maintained. These logbooks and notebooks (and supporting forms) contain detailed information required for data interpretation or documentation, but are not easily useful for tracking and reporting of progress. Furthermore, the field logbook/notebooks remain onsite for extended periods of time and are thus not accessible for timely review by project management.

5.4.1 Daily Activities Report

To provide timely oversight of onsite contractors, Daily Activities Reports are completed and submitted as described below.

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5.4.1.1 Description

The Daily Activities Report (DAR) documents the activities and progress for each day's field work. This report must be filled out on a daily basis whenever there are drilling, test pitting, well construction, or other related activities occurring which involve subcontractor personnel. These sheets summarize the work performed and form the basis of payment to subcontractors. The DAR form can be found on the TtNUS intranet site.

5.4.1.2 Responsibilities

It is the responsibility of the rig geologist to complete the DAR and obtain the driller's signature acknowledging that the times and quantities of material entered are correct.

5.4.1.3 Submittal and Approval

At the end of the shift, the rig geologist must submit the Daily Activities Report to the Field Operations Leader (FOL) for review and filing. The Daily Activities Report is not a formal report and thus requires no further approval. The DAR reports are retained by the FOL for use in preparing the site logbook and in preparing weekly status reports for submission to the Project Manager.

5.4.2 Weekly Status Reports

To facilitate timely review by project management, photocopies of logbook/notebook entries may be made for internal use.

It should be noted that in addition to summaries described herein, other summary reports may also be contractually required.

All Tetra Tech NUS field forms can be found on the company's intranet site at http://intranet.ttnus.com under Field Log Sheets.

6.0 LISTING OF TETRA TECH NUS FIELD FORMS FOUND ON THE TTNUS INTRANET SITE. HTTP://INTRANET.TTNUS.COM CLICK ON FIELD LOG SHEETS

Groundwater Sample Log Sheet Surface Water Sample Log Sheet Soil/Sediment Sample Log Sheet Container Sample and Inspection Sheet Geochemical Parameters (Natural Attenuation) Groundwater Level Measurement Sheet Pumping Test Data Sheet Packer Test Report Form Boring Log Monitoring Well Construction Bedrock Flush Mount Monitoring Well Construction Bedrock Open Hole Monitoring Well Construction Bedrock Stick Up Monitoring Well Construction Confining Layer Monitoring Well Construction Overburden Flush Mount Monitoring Well Construction Overburden Stick Up Test Pit Log Monitoring Well Materials Certificate of Conformance Monitoring Well Development Record

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Daily Activities Record
Field Task Modification Request
Hydraulic Conductivity Test Data Sheet
Low Flow Purge Data Sheet
QA Sample Log Sheet
Equipment Calibration Log
Field Project Daily Activities Checklist
Field Project Pre-Mobilization Checklist

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ATTACHMENT A TYPICAL SITE LOGBOOK ENTRY

SITE LEA	ADER:		
PERSON	NEL:	DRILLER	SITE VISITORS
WEATHE	ER: Clear, 68°F, 2-5 mph wir	nd from SE	
ACTIVITI	ES:		
1.	Steam jenney and fire hos	10212020	
2.	Notebook, No. 1, page 2 see sample logbook, pa	9-30, for details of drilling activity ge 42. Drilling activities completed	. See Geologist's y. Sample No. 123-21-S4 collected; eted at 11:50 and a 4-inch stainless age 31, and well construction details
3.	Drilling rig No. 2 steam- well	cleaned at decontamination	pit. Then set up at location of
4.	No. 2, page for de	geologist was etails of drilling activities. Samp ; see sample logbook, pages 43	See Geologist's Notebook, ple numbers 123-22-S1, 123-22-S2, 3, 44, and 45.
5.		the pitcher pump for 1 hour. At	filled in the flushing stage. The well the end of the hour, water pumped
6.	EPA remedial project man	ger arrives on site at 14:25 hour	rs.
7.	Large dump truck arrives over test pit	at 14:45 and is steam-cleaned	d. Backhoe and dump truck set up
8.	activities. Test pit subs	ee Geologist's Notebook, No. sequently filled. No samples table, filling in of test pit result	mp truck. Rig geologist was 1, page 32, for details of test pit aken for chemical analysis. Due to lted in a very soft and wet area. A
9.			ogbook, pages 42 through 45) at Ill personnel off site, gate locked.
	+	Field Operations Leader	

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ATTACHMENT B

TŁ	Tetra Tech 661 Anders Pittsburgh, (412)921-70	en Drive 15220	Project: Site: Location:		
Sample N	lo:			Matrix:	
Date:		Time:	Preser	ve:	
Analysis					
Sampled by:			Laborat	ory:	

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0
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2

PROJE	PROJECT NO: FACILITY;			PROJECT MANAGER			1	PH	PHONE NUMBER LABORATOR				ABORATORY NAME AND CONTACT:						D							
SAMP	LERS (SIGNATU				RS (SIGNATURE)						OPER	ATIONS	LEADER	P	ONE NU	MBER		ADE	RESS						Ö)
		The state of		CARR	UERUWA	AYBILL	NUMBER	+	-			CIT	Y, STATE						ME							
STANDARD TAT RUSH TAT 72 hr. 7 day 14 day						TOP DEPTH (FT) BOTTOM DEPTH (FT) MATRIX (GW, SO, SW, SD, QC, ETC.) COLLECTION METHOD		CONTAINER TYPE PLASTIC (P) or GLASS PRESERVATIVE USED THE THINTS			5 (G)	(G) // // // // // // // // // // // // //				-	FIELD DOCUMENTATION									
DATE	TIME	SAMPLE ID	LOCATION ID	тор ВЕРТН (FT)	воттом вертн (FT)	MATRIX (GW	COLLECTION METHOD GRAP (G) COMP (C)	No. OF CONTAINERS	THE	/	/	//	//	/	/	/	COMMENTS	ATT,	Revision	Number						
		k C																ATTACHMENT C	N	SA-6.3						
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3. RELINQUISHED BY			DATE TIME				3, R	ECEIVED	BY				DATE TIME		TIME			N								

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ATTACHMENT D

CHAIN-OF-CUSTODY SEAL

Date Signature **CUSTODY SEAL**

Date

Signature

CUSTODY SEAL

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019611/P



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Applicability

Tetra Tech NUS, Inc.

Prepared

Earth Sciences Department

Subject DECONTAMINATION OF FIELD EQUIPMENT

Approved

Tom Johnston



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1.0 PURPOSE

Decontamination is the process of removing and/or neutralizing site contaminants that have contacted and/or accumulated on equipment. The purpose of this Standard Operating Procedure (SOP) is to protect site personnel, the general public, and the environment while preserving or maintaining sample integrity. It is further intended through this procedure to describe the steps necessary for proper decontamination of drilling equipment, earth-moving equipment, chemical sampling equipment and field operation and analytical equipment.

2.0 SCOPE AND APPLICABILITY

This procedure applies to all equipment used to provide access to/acquire environmental samples that may have become contaminated through direct contact with contaminated media including air, water, and soil. This equipment includes drilling and heavy equipment and chemical sampling and field analytical equipment. Where technologically and economically feasible, single-use sealed disposable equipment will be employed to minimize the potential for cross-contamination. This SOP also provides general reference information on the control of contaminated materials.

Decontamination methods and equipment requirements may differ from one project to another. General equipment items are specified in Section 6.0, but project-specific equipment must be obtained to address the project-specific decontamination procedures presented in Section 7.0 and applicable subsections.

3.0 GLOSSARY

Alconox/Liquinox - A brand of phosphate-free laboratory-grade detergent.

<u>Decontamination Solution</u> - A solution selected/identified in the Health and Safety Plan or Project-Specific Quality Assurance Plan. The solution is selected and employed as directed by the project chemist/health and safety professional.

<u>Deionized Water (DI)</u> - Tap water that has been treated by passing through a standard deionizing resin column. This water may also pass through additional filtering media to attain various levels of analyte-free status. The DI water should meet College of American Pathologists (CAP) and National Committee for Clinical Laboratory Standards (NCCLS) specifications for reagent-grade Type I water.

<u>Potable Water</u> - Tap water from any municipal water treatment system. Use of an untreated potable water supply is not an acceptable substitute for tap water.

<u>Pressure Washing</u> - Process employing a high-pressure pump and nozzle configuration to create a high-pressure spray of potable water. High-pressure spray is employed to remove solids from equipment.

<u>Solvent</u> – A liquid in which solid chemicals or other liquids are dissolved. The solvent of choice is pesticide-grade isopropanol. Use of other solvents (methanol, acetone, or hexane) may be required for particular projects or for a particular purpose (e.g., removal of concentrated waste) and must be justified in the project planning documents. For example, it may be necessary to use hexane when analyzing for trace levels of pesticides, PCBs, or fuels. In addition, because many of these solvents are not miscible in water, the equipment should be air dried prior to use. Solvents should not be used on PVC equipment or well construction materials.

<u>Steam Pressure Washing</u> - A cleaning method employing a high-pressure spray of heated potable water to remove various organic/inorganic chemicals from equipment.

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4.0 RESPONSIBILITIES AND PERSONNEL QUALIFICATIONS

<u>Project Manager</u> - Responsible for ensuring that all field activities are conducted in accordance with approved project plan(s) requirements.

<u>Decontamination Personnel</u> - Individuals assigned the task of decontamination. It is the responsibility of these individuals to understand the use and application of the decontamination process and solutions as well as the monitoring of that process to ensure that it is working properly. This is accomplished through visual evaluation, monitoring instrument scanning of decontaminated items, and/or through the collection of rinsate blanks to verify contaminant removal.

<u>Field Operations Leader (FOL)</u> - Responsible for the implementation of project-specific planning documents. This includes on-site verification that all field activities are performed in compliance with approved SOPs or as otherwise dictated by the approved project plan(s). The FOL is also responsible for the completion and accuracy of all field documentation.

<u>Site Safety Officer (SSO)</u> - Exercises shared responsibility with the FOL concerning decontamination effectiveness. All equipment arriving on site (as part of the equipment inspection), leaving the site, and moving between locations is required to go through a decontamination evaluation. This is accomplished through visual examination and/or instrument screening to determine the effectiveness of the decontamination process. Improper or incomplete decontamination is sufficient to restrict equipment from entering the site, exiting the site, or moving to a new location on the site until the objectives are successfully completed.

General personnel qualifications for decontamination activities include the following:

- Occupational Safety and Health Administration (OSHA) 40-hour and applicable refresher training.
- Capability of performing field work under the expected physical and environmental (i.e., weather)
 conditions.
- Familiarity with appropriate decontamination procedures.

5.0 HEALTH AND SAFETY

In addition to the health and safety issues and reminders specified in subsections of this SOP, the following considerations and requirements must be observed as SOPs for field equipment decontamination activities:

- If any solvents or hazardous chemicals (e.g., isopropyl alcohol) are to be used in equipment decontamination activities, the FOL must first obtain the manufacturer's/supplier's Material Safety Data Sheet (MSDS) and assure that it is reviewed by all users (prior to its use), added to the site Hazardous Chemical Inventory, and maintained on site as part of the project Hazard Communication Program.
- Review and observe specific health and safety requirements (e.g., personal protective equipment [PPE]) specified in the project-specific health and safety plan for this activity.

6.0 EQUIPMENT LIST

Wood for decontamination pad construction, when applicable (see Section 7.1).

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- Tools for constructing decontamination pad frame, when applicable (see Section 7.1).
- Visqueen sheeting or comparable material to cover decontamination pad frame, when applicable (see Section 7.1).
- Wash/drying racks for auger flights and drill/drive rods, when applicable (see Section 7.2).
- PPE as specified in the project health and safety plan.
- Soap and water for washing and rinsing.
- Deionized water for final rinsing.
- Solvents (e.g., pesticide-grade isopropanol) for rinsing (see applicable portions of Section 7.2).
- Tubs, buckets, etc. for containerizing rinse water (see applicable portions of Section 7.2).
- Sample bottles for collecting rinsate blanks (see Section 7.2).
- Calibrated photoionization detector (PID) or flame ionization detector (FID) to monitor decontaminated equipment for organic vapors generated through the existence of residual contamination or the presence of decontamination solvent remaining after the piece was rinsed.
- Aluminum foil or clear clean plastic bag for covering cleaned equipment (see applicable portions of Section 7.2).
- Paper towels or cloths for wiping.
- Brushes, scrapers, or other hand tools useful for removing solid materials from equipment.
- Clear plastic wrap for covering or wrapping large decontaminated equipment items (see Section 7.2.2).
- Drum-moving equipment for moving filled waste drums (optional) (see Section 7.3).
- Drum labels for waste drums (see Attachment A).

7.0 PROCEDURES

The process of decontamination is accomplished through the removal of contaminants, neutralization of contaminants, or isolation of contaminants. To accomplish this activity, preparation is required including site preparation, equipment selection, and evaluation of the decontamination requirements and processes. Site contaminant types, concentrations, and media types are primary drivers in the selection of the types of decontamination and where it will be conducted. For purposes of this SOP, discussion is limited to decontamination procedures for general environmental investigations.

Decontamination processes will be performed at the location(s) specified in project-specific planning documents. Typical decontamination locations include the following:

- Temporary decontamination pads/facilities
- Sample locations
- Centralized decontamination pad/facilities

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Combination of some or all of the above

The following discussion includes general considerations for the decontamination process. Specific construction and implementation procedures will be as specified in the project-specific planning documents and/or may be as dictated by site-specific conditions as long as the intent of the requirements in the planning documents is met. This intent is to contain any residual fluids and solids generated through the decontamination process.

7.1 <u>Decontamination Pad Design/Construction Considerations</u>

7.1.1 Temporary Decontamination Pads

Temporary decontamination pads may be constructed at satellite locations within the site area in support of temporary work areas. These structures are generally constructed to support the decontamination of heavy equipment such as drill rigs and earth-moving equipment but can be employed for smaller articles.

The purpose of the decontamination pad is to contain wash waters and potentially contaminated soil generated during decontamination procedures. Therefore, construction of these pads should take into account the following considerations:

- Site location The decontamination site selected should be far enough from the work site to maximize decontamination effectiveness while minimizing travel distance. The location of the decontamination site shall be selected to provide, in the judgment of the FOL or FOL designee, compliance with as many of the following characteristics as practicable:
 - Well removed from pedestrian/vehicle thoroughfares.
 - Avoidance of areas where control/custody cannot be maintained.
 - Avoidance of areas where potential releases of contaminated media or decontamination fluids may be compounded through access to storm water transport systems, streams, or other potentially sensitive areas.
 - Avoidance of potentially contaminated areas.
 - Avoidance of areas too close to the ongoing operation, where cross-contamination may occur.

The selected decontamination site should include the following, where possible:

- Areas where potable water and electricity are provided.

Safety Reminder

When utilizing electrical power sources, either hard-wired or portable-generated sources, ensure that:

- All power is routed through a Ground Fault Circuit Interrupter (GFCI).
- All power cords are in good condition (no physical damage), rated for the intended energy load, and designated for outdoor use.

In situations where accomplishing these elements is not possible, it will be necessary to implement a site electrical grounding program.

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- Areas where support activities such as removing decontamination waters soil and sediment are possible without entering an active exclusion zone.
- Areas that offer sufficient size to carry out the specific decontamination sequence.
- Decontamination pad (decon pad) The decon pad shall be constructed to meet the following characteristics:
 - Size The size of the pad should be sufficient to accept the equipment to be decontaminated as well as permitting free movement around the equipment by the personnel conducting the decontamination. The size should permit these movements utilizing pressure/steam washer wands and hoses and minimizing splash due to work in close quarters.
 - Slope An adequate slope will be constructed to permit the collection of water and potentially contaminated soil within a trough or sump constructed at one end. The collection point for wash waters should be of adequate distance that the decontamination workers do not have to walk through the wash waters while completing their tasks. Because the pad will be sloped, place a light coating of sand over the plastic to minimize potential slips and falls. See the text about liners below.
 - Sidewalls The sidewalls shall be at least 6 inches in height (or as high as possible if 6 inches is not achievable) to provide adequate containment for wash waters and soil. If splash represents a potential problem, splash guards should be constructed to control overspray. Sidewalls may be constructed of wood, inflatables, sand bags, etc. to permit containment. Splash guards are typically wood frames with Visqueen coverings to control overspray.
 - Liner Depending on the types of equipment and decontamination method to be used, the liner should be of sufficient thickness to provide a puncture-resistant barrier between the decontamination operation and the unprotected environment. Care should be taken to examine the surface area prior to placing the liner to remove sharp articles (sticks, stones, debris) that could puncture the liner. Liners are intended to form an impermeable barrier. The thickness may vary from a minimum recommended thickness of 10 mil to 30 mil. The desired thickness may be achieved through layering materials of lighter construction. It should be noted that various materials (rubber, polyethylene sheeting) become slippery when wet. To minimize this potential hazard associated with a sloped liner, a light coating of sand shall be applied to provide traction as necessary.
 - Wash/drying racks Auger flights, drill/drive rods, and similar equipment require racks positioned off of the ground to permit these articles to be washed, drained, and dried while secured from falling during this process.

For decontamination of direct-push technology (DPT) equipment, the pad may be as simple as a mortar tub containing buckets of soapy water for washing and an empty bucket to capture rinse waters. Decontamination may be conducted at the rear of the rig to permit rapid tool exchange.

- Maintenance Maintain the decontamination area by:
 - Periodically clearing the work area of standing water, soil, and debris, and coiling hoses to aid in eliminating slip, trip, and fall hazards. In addition, these articles will reduce potential backsplash and cross-contamination.

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- Regularly changing the decontamination fluids to ensure proper cleaning and prevent cross-contamination.
- PPE Periodically evaluate the condition of, and maintain the decontamination equipment, including regular cleaning of face shields and safety glasses. This is critical to ensuring the safety of decontamination personnel and the integrity of the decontamination process, and it will ensure that equipment is functioning properly.

7.1.2 Decontamination Activities at Drill Rigs/DPT Units

During subsurface sampling activities including drilling and DPT activities, decontamination of drive rods, Macro Core Samplers, split spoons, etc. is typically conducted at an area adjacent to the operation. Decontamination is generally accomplished using a soap/water wash and rinse utilizing buckets and brushes. This area requires sufficient preparation to accomplish the decontamination objectives.

Buckets shall be placed within mortar tubs or similar secondary containment tubs to prevent splash and spills from reaching unprotected environmental media. Drying racks shall be employed as directed for temporary pads to permit parts to dry and be evaluated prior to use/reuse. Methodology regarding this activity is provided in Section 7.2.

7.1.3 Decontamination Activities at Remote Sample Locations

When sampling at remote locations, sampling equipment such as trowels and pumps/tubing should be evacuated of potentially contaminated media to the extent possible. This equipment should be wrapped in plastic for transport to the temporary/centralized decontamination location for final cleaning and disposition. Flushing and cleaning of single-use equipment such as disposable trowels, tubing, and surgeon's gloves may allow disposal of this equipment after visible soil and water remnants have been removed.

7.2 <u>Equipment Decontamination Procedures</u>

The following represents procedures to be employed for the decontamination of equipment that may have contacted and/or accumulated contamination through site investigation activities.

7.2.1 Monitoring Well Sampling Equipment

- 7.2.1.1 <u>Groundwater sampling equipment This includes pumps inserted into monitoring wells such as bladder pumps, Whale pumps, and Redi-Flo pumps and reusable bailers, etc.</u>
- 1. Evacuate to the extent possible, any purge water within the pump/bailer.
- 2. Scrub using soap and water and/or steam clean the outside of the pump/bailer and, if applicable, the pump tubing.
- 3. Insert the pump and tubing/bailer into a clean container of soapy water. Pump/run a sufficient amount of soapy water through the pump/bailer to flush out any residual well water. After the pump is flushed, circulate soapy water through the pump to ensure that the internal components are thoroughly flushed.
- 4. Remove the pump and tubing/bailer from the container
- 5. Rinse external pump components using tap water.

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6. Insert the pump and tubing/bailer into a clean container of tap water. Pump/run a sufficient amount of tap water through the pump/bailer to evacuate all of the soapy water (until clear).

CAUTION

Do not rinse PE, PVC, and associated tubing with solvents –
Use the procedures defined in the project-specific planning documents. If they are not defined, contact the FOL for guidance. The solvent rinse described in Step 7 may be omitted if groundwater does not contain oil, grease, PAHs, PCBs, or other hard to remove organic materials.

- 7. If groundwater contains or is suspected to contain oil, grease, PAHs, PCBs, or other hard to remove organic materials, rinse the equipment to be cleaned with pesticide-grade isopropanol.
- 8. Pass deionized water through the hose to flush out the tap water and solvent residue as applicable.
- 9. Drain residual deionized water to the extent possible.
- 10. Allow components of the equipment to air dry.
- 11. For bladder pumps, disassemble the pump and wash the internal components with soap and water, then rinse with tap water, isopropanol, and deionized water and allow to dry. After the parts are dry, conduct a visual inspection and a monitoring instrument scan to ensure that potential contaminants and all decontamination solvent have been removed. Collect a rinsate blank in accordance with the project-specific planning documents to ensure that the decontamination process is functioning as intended. The typical frequency of collection for rinsate blanks is 1 per 20 field samples. In addition, wipe samples or field tests such as UV light may be used.
- 12. Wrap pump/bailer in aluminum foil or a clear clean plastic bag for storage.

SAFETY REMINDER

Remember when handling powered equipment to disconnect the power source and render the equipment to a zero energy state (both potential and kinetic) before opening valves, disconnecting lines, etc.

7.2.1.2 Electronic Water Level Indicators/Sounders/Tapes

During water level measurements, rinsing the extracted tape and probe with deionized water and wiping the surface of the extracted tape between locations is acceptable. However, periodic full decontamination should be conducted as follows:

- 1. Wash with soap and water
- 2. Rinse with tap water
- 3. Rinse with deionized water

NOTE

In situations where oil, grease, free product, other hard to remove materials are encountered, probes and exposed tapes should be washed in hot soapy water. If probes or tapes cannot be satisfactorily decontaminated (they are still stained, discolored, etc.), they should be removed from service.

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7.2.1.3 <u>Miscellaneous Equipment</u>

Miscellaneous equipment including analytical equipment (water quality testing equipment) shall be cleaned per manufacturers' instructions. This generally includes wiping the sensor housing and rinsing with tap and deionized water.

Coolers/shipping containers employed to ship samples are received from the laboratory in a variety of conditions including marginal to extremely poor. Coolers shall be evaluated prior to use for the following:

- Structural integrity Coolers missing handles or having breaks in the outer housing should be removed and not used. Notify the laboratory that the risk of shipping samples in the cooler(s) provided is too great and request a replacement unit.
- Cleanliness As per protocol, only volatile organic samples are accompanied by a trip blank. If a
 cooler's cleanliness is in question (visibly dirty/stained) or if there are noticeable odors, the cooler
 should be decontaminated prior to use as follows:
 - 1. Wash with soap and water
 - 2. Rinse with tap water
 - 3. Dry

If these measures fail to clean the cooler to an acceptable level, remove the unit from use as a shipping container and ask the cooler provider (e.g., the analytical laboratory) to provide a replacement unit.

7.2.2 Downhole Drilling Equipment

This includes any portion of the drill rig that is over the borehole, including auger flights, drill stems, rods, and associated tooling that would extend over the borehole. The following procedure is to be employed prior to initiating the drilling/sampling activity, then between locations:

CAUTION

Exercise care when using scrapers to remove soil and debris from downhole drilling equipment. Inadvertent slips of scrapers have resulted in cuts, scrapes, and injured knuckles, so use scrapers carefully when removing soil from these items.

- 1. Remove loose soil using shovels, scrapers, etc.
- 2. Through a combination of scrubbing using soap and water and/or steam cleaning or pressure washing, remove visible dirt/soil from the equipment being decontaminated.

CAUTION

In Step 3, do not rinse PE, PVC, and associated tubing with solvents. The appropriate procedures should be defined within the project-specific planning documents. If they are not defined, contact the FOL for guidance. The solvent rinse described in Step 4 may be omitted if groundwater does not contain oil, grease, PAHs, PCBs, or other hard to remove organic materials.

3. Rinse the equipment with tap water, where applicable (steam cleaning and pressure washing incorporate rinsing as part of the process).

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- 4. If the equipment has directly or indirectly contacted contaminated sample media and is known or suspected of being contaminated with oil, grease, PAHs, PCBs, or other hard to remove organic materials, rinse equipment with pesticide-grade isopropanol
- 5. To the extent possible, allow components to air dry.
- If the decontaminated equipment is to be used immediately after decontamination, screen it with a
 calibrated photoionization detector (PID)/flame ionization detector (FID) to ensure that all
 contaminants and possible decontamination solvents (if they were used) have been adequately
 removed.
- 7. Wrap or cover equipment in clear plastic until it is time to be used.

SAFETY REMINDER

Even when equipment is disconnected from power sources, dangers such as the following may persist:

- <u>Falls</u> An auger flight standing on its end may fall and injure someone. Secure all loose articles to prevent heavy articles from falling onto people or equipment.
- <u>Burns</u> Steam cleaner water is heated to more than 212 °F and exhibits thermal energy that can cause burns. Prevent contact of skin with hot water or surfaces.

<u>High water pressure</u> - Pressure washer discharge can have 2,000 to 4,000 psi of water pressure. Water under this amount of pressure can rupture skin and other human tissues. Water at 4,000 psi exiting a 0° tip can be dangerous because of its relatively high cutting power. The exit velocity and cutting power of the water are reduced when exiting a 40° fan tip, but damage to soft tissues is still possible.

In general, follow the rules below to avoid injury, equipment damage, or incomplete decontamination:

- 1. Read the operating manual and follow the manufacturers' recommended safety practices before operating pressure washers and steam cleaners.
- Never point the pressure washer or steam cleaner at another person or use to clean your boots or other parts of your body. Water lacerations and burns may appear to be minor at first but can be life threatening. Do not attempt to hold small parts in your hand while washing them with hightemperature or high-pressure water.
- 3. Always wear PPE as specified in the HASP such as:
 - Hard hat, safety glasses, splash shield, impermeable apron or splash suit, and hearing protection. Remember that excessive noise is a hazard when operating gas-powered engines and electrically driven pressure washers. PPE will be identified in your project specific planning documents.
- 4. Inspect each device before use. An inspection checklist will be provided in the project-specific planning documents. If it is a rented device, safety measures are typically provided by the vendor. In all cases, if you are not familiar with the operation of a pressure washer/steam cleaner, do not operate it until you obtain and thoroughly review operating instructions and recommended safety practices.
- 5. Do not modify equipment unless the manufacturer has approved the modifications.

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7.2.3 Soil/Sediment Sampling Equipment

This section applies to soil sampling equipment including but not limited to hand augers, stainless steel trowels/spoons, bowls, dredges, scoops, split spoons, Macro Core samplers, etc.

- 1. Remove all loose soil from the equipment through manual means.
- 2. Through a combination of scrubbing using soap and water and/or steam cleaning or pressure washing, remove visible dirt/soil from the equipment.
- 3. Rinse the equipment with tap water.

CAUTION

Do not rinse PE, PVC, and associated tubing with solvents. The appropriate procedures should be defined within the project-specific planning documents. If they are not defined, contact the FOL for guidance. The solvent rinse described in Step 4 may be omitted if groundwater does not contain oil, grease, PAHs, PCBs, or other hard to remove organic materials.

- 4. If the equipment is contaminated or suspected to be contaminated with oil, grease, PAHs, PCBs, or other hard to remove organic materials, rinse the equipment with pesticide-grade isopropanol.
- 5. Rinse the equipment with deionized water.
- 6. To the extent possible, allow components to air dry.
- 7. If the equipment is to be used immediately after decontamination, screen it with a calibrated PID/FID to ensure that all solvents (if they were used) and trace contaminants have been adequately removed.
- 8. After the equipment has dried, wrap it in aluminum foil for storage until use.

Dredges employed in sediment sampling are typically decontaminated as follows:

- Remove the sediment sample from the sampling device
- If sufficient associated surface water is available at the sampling site, place the dredge in the water and flush to remove visible sediment.
- Extract the dredge and wash it in soap and water per the project-specific planning documents.

CAUTION

When handling dredges, the primary safety concern is trapping fingers or extremities in the larger dredge samplers within the jaws or pinch points of the mechanical jaws. Keep hands, fingers, and extremities away from these pinch and compression points. Either handle the device by the rope or preferably lock the jaws in place to control the potential for closing during maintenance and/or cleaning.

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7.3 Contact Waste/Materials

During the course of field investigations, disposable/single-use equipment becomes contaminated. These items include tubing, trowels, PPE (gloves, overboots, splash suits, etc.), and broken sample containers.

With the exception of the broken glass, single-use articles should be cleaned (washed and rinsed) of visible materials and disposed as normal refuse. The exception to this rule is that extremely soiled materials that cannot be cleaned shall be containerized for disposal in accordance with applicable federal, state, and local regulations.

7.3.1 Investigation-Derived Wastes - Decontamination Wash Waters and Sediments

NOTE

Requirements for waste storage may differ from one facility to the next. Facility-specific directions for waste storage areas will be provided in project-specific documents, or separate direction will be provided by the Project Manager.

- Assume that all investigation-derived waste (IDW) generated from decontamination activities contains
 the hazardous chemicals associated with the site unless there are analytical or other data to the
 contrary. Waste solution volumes could vary from a few gallons to several hundred gallons in cases
 where large equipment required cleaning.
- 2. Where possible, use filtering systems to extend the use of water within a closed system wash unit to recycle water and to reduce possible waste amounts.

NOTE

Containerized waste rinse solutions are best stored in 55-gallon drums (or equivalent containers) that can be sealed until ultimate disposal at an approved facility.

- 3. Label waste storage containers appropriately labeled (see Attachment A).
- 4. Ensure that the IDW storage area is configured to meet the following specifications to permit access to the containers and to conduct spill/leak monitoring, sampling, and extraction when the disposal route is determined:
 - Enclose areas accessible by the general public using construction fencing and signs.
 - Stored materials in 55-gallon drums on pallets with four (or fewer) drums per pallet.
 - Maintain the retaining bolt and label on the outside of storage containers where readily visible.
 - Provide at least 4 feet of room between each row of pallets to allow access to containers for sampling, drum removal, and spill response.
 - As directed in project-specific planning documents, maintain an IDW Inventory List and provide the list to the site Point of Contact at the termination of each shift.
 - Maintain spill response equipment at the IDW storage area in case it is required for immediate access.

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	 Where possible, use equipment manipulate containers. 	for moving containers. Where no	t possible, obtain help to

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CAUTION

Each container of water can weigh up to 490 pounds. Each 55-gallon drum of wet soil can weigh more than 750 pounds. Fill drums and temporary containers to 80 percent capacity to minimize spill and handling difficulties. Use drum carts to move filled drums.

See safe lifting techniques provided in Section 4.4 of the Tetra Tech NUS, Inc. Health and Safety Guidance Manual.

When placing drums, keep your fingers out of pinch and smash points such as between the drums. In some cases such as well development and/or purge water, you can place the drums to be filled on the pallet and transport materials in smaller easier to handle containers.

7.4 <u>Decontamination Evaluation</u>

Upon decontamination of equipment, determine the effectiveness of the decontamination process in the following manner:

- Visual evaluation A visual evaluation will be conducted to ensure the removal of particulate matter. This shall be done to ensure that the washing/rinsing process is working as intended.
- Instrument Screening A properly calibrated PID/FID should be used to evaluate the presence of site contaminants and solvents used in the cleaning process. The air intake of the instrument shall be passed over the article to be evaluated. Avoid placing the instrument probe into residual waters. A PID/FID reading greater than the daily established background level requires a repeat of the decontamination process, followed by rescreening with the PID/FID. This sequence must be repeated until no instrument readings greater than the daily established background level are observed. It should be noted that the instrument scan is only viable if the contaminants are detectable within the instrument's capabilities.

NOTE

When required by project-specific planning documents, collection of rinsate blanks (see next step) shall be completed without exception unless approval to not collect these samples is obtained from the Project Manager.

- Collection of Rinsate Blanks It is recommended that rinsate samples be collected to:
 - Evaluate the decontamination procedure representing different equipment applications (pumps versus drilling equipment) and different decontamination applications.
 - Single-use disposable equipment The number of samples should represent different types of equipment as well as different lot numbers of single-use articles.
 - The collection and the frequency of collection of rinsate samples are as follows unless specified differently in the project-specific planning documents:
 - Per decontamination method
 - Per disposable article/batch number of disposable articles

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NOTE

It is recommended that an initial rinsate sample be collected early in the project to ensure that the decontamination process is functioning properly and to avoid using a contaminated batch of single-use articles. It is recommended that a follow-up sample be collected later during the execution of the project to ensure that those conditions do not change.

Rinsate samples collection may be driven by types of and/or levels of contaminant. Difficult to remove contaminants, oils/greases, some PAHs/PCBs, etc. may also support the collection of additional rinsates due to the obvious challenges to the decontamination process. This is a field consideration to be determined by the FOL.



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Applicability

Tetra Tech NUS, Inc.

Prepared

Earth Sciences Department

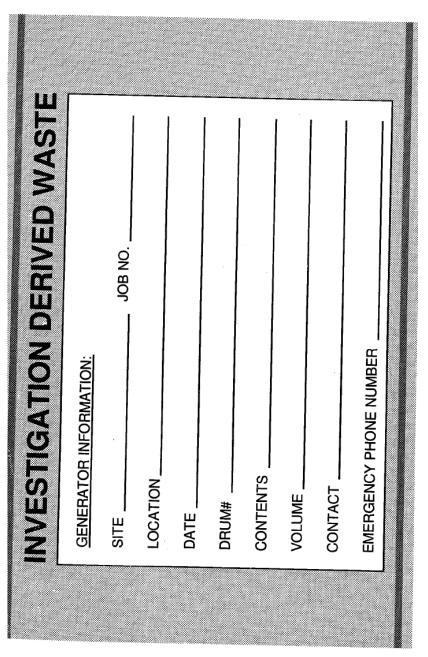
Subject DECONTAMINATION OF FIELD EQUIPMENT Appr

Approved

Tom Johnston

TE Johnston

Attachment A iDW Label



Asbestos Bulk Sampling SOP

Sci-Tek Environmental Services Company

1. <u>Definitions</u>

- □ Asbestos Containing Material (ACM) Any material containing more than one percent asbestos. (OSHA 1926.1101)
- Presumed Asbestos Containing Material (PACM) Thermal system insulation and surfacing material found in buildings constructed no later than 1980. (OSHA 1926.1101)
- □ Friable A material which, when dry, may be crumbled, pulverized, or reduced to powder by hand pressure.
- □ Functional Space Under AHERA, a room, group of rooms or homogeneous area designated by a person accredited to prepare management plans, design abatement projects or conduct response actions. (EPA 40 CFR 763)
- Homogenous Area In accordance with AHERA definitions, an area of surfacing material, TSI, or miscellaneous material that is uniform in color, texture, and appearance. (EPA 40 CFR 763)
- Polarized Light Microscopy (PLM) recognized analytical method for identification of ACM.
- Surfacing Materials Category of ACM indicating material that is sprayed, troweled on or otherwise applied to surfaces. Examples include acoustical plaster on ceilings or fireproofing materials on structural members.
- □ Thermal System Insulation (TSI) Category of ACM indicating material applied to pipes, fittings, boilers, breeching tanks, ducts or other structural components to prevent heat loss or gain.
- Miscellaneous Material Category of ACM indicating interior building material on structural components, structure members of fixtures, such as floor and ceiling tiles, and does not include surfacing material or thermal system insulation.
- Building Inspector Determines if ACM is present in a building and makes an assessment of the physical condition of the ACM. Prerequisites include a high school diploma, attendance of initial and refresher training sessions, and state licensing.

- Management Planner Uses the information provided by the Building Inspector to make hazard assessments, recommends response actions and develops Operation and Maintenance (O&M) plans for the ACM. Prerequisites include the individual is an architect, certified industrial hygienist or have a related scientific degree as well as attendance of initial and refresher training sessions and state licensing.
- Project Designer Develops the specifications for contracts and provides working drawings and may specify reinsulation or replacement materials. May also be retained to assist in bid solicitation and contractor selection and to assume day-to-day project management responsibilities. Prerequisites include attendance of initial and refresher training sessions through an EPA-approved training course.

2. Pertinent Regulations

Federal

- Occupational Exposure to Asbestos; Construction Industry Standard 29 CFR 1926.1101
- Asbestos Worker Protection; Final Rule 40 CFR Part 763
- NESHAP National Emissions Standard for Hazardous Air Pollutants 40 CFR Part
 Subpart M
- AHERA Asbestos Hazard Emergency Response Act 40 CFR 763 Subpart E,
 October 30, 1987
- 29 CFR 1910.134, OSHA Respiratory Protection Standard
- 29 CFR 1910.1200 OSHA Safety and Health Standards Subpart Z Toxic and Hazardous Substances Hazard Communication

State / Local

- Asbestos Occupations Accreditation and Certification Act Pennsylvania Act 194
- State of West Virginia Asbestos Abatement Licensing Rule Title 64 Series 73
- County of Allegheny, Pennsylvania, Ordinance No. 16782 Allegheny County
 Health Department Rules and Regulations, Article XXI Air Pollution Control
 Asbestos Abatement Edition

3. Planning and Designing the Sampling Operation

Review previous building inspections, sampling records, abatement records and building records / drawings where available.

Identify equipment needed for the job, to include personal protective equipment, bulk sampling equipment, and administrative supplies. A list of equipment and supplies likely to be used for the bulk sampling event is provided in Appendix A. Examples of typical field sheets used are provided in Appendix B.

Identify analysis methods to be used, laboratory to be used, turnaround time for the analysis, and other cost-saving methods such as analysis to first positive and whether point counting will be utilized for materials testing less than 10% ACM.

Identify the number of samples to be taken for each surfacing, thermal system insulation, and miscellaneous material. Select appropriate sample locations.

Identify sampling areas / homogeneous areas. Homogeneous areas can be grouped by floor, by room, etc. Materials in different wings of a building, on different floors, or in special areas should be assigned to separate homogeneous areas unless there is good reason to believe the material is identical throughout.

Review the sampling schedule with the owner or owners' representative. Ensure access to locked areas, out-of-reach areas, unused areas, etc. Proper notification is necessary for employee organizations, building occupants, and others who will be impacted by the bulk sampling event, with respect to the "right to know" of others.

Establish whether destructive sampling methods will be used, and if materials can be presumed positive for ACM. Establish whether hidden areas can be accessed (ex. materials behind plaster walls). Determine if exterior materials are to be sampled (ex. roofing materials).

Prepare diagrams to show sample locations and square footages (room dimensions). Windows and door locations should also be noted.

4. Collecting Bulk Samples

- a. Demarcate sampling area.
- b. Spread drop cloth / set up ladder
- c. Put on personal protective equipment (At least a half-face respirator with P-100 filters and protective clothing)
- d. Label bulk sample container, record number and location, description and quantity of material on field sheets, diagrams, and chain-of-custody forms. Take photos of collection sites.
- e. Moisten area where sample is to be extracted.
- f. Extract sample using a clean tool, sample to the substrate.
- g. Place sample in container, tightly seal the container.
- h. Clean tools and any sampling debris created by the sampling process.
- i. Fill and patch sampling areas.
- j. Ensure any discarded material is handled properly.

5. Analytical Techniques for Bulk Samples

Polarized light microscopy (PLM) is the EPA-approved method for analyzing bulk materials for asbestos. The method number for PLM bulk sampling is EPA 600/R-93/116.

The U.S. EPA's NESHAP regulations require that point counting analysis be performed when analyzing samples collected from buildings or operations covered by the regulation. This technique is conducted to quantify asbestos in samples where asbestos content is less than 10% when standard PLM is used.

Samples should be analyzed by a laboratory that is accredited through the National Voluntary Laboratory Accreditation Program (NVLAP), administered by the National Institute of Standards and Technology (NIST). Chain-of-custody forms accompany all samples at all times. Chain-of-custody forms must be completed by the inspector and signed by all persons handling the samples.

Appendix A

List of Equipment and Supplies Used for a Bulk Sampling Event

Commonly Used Personal Protective Equipment

- Respirators: Minimum level of protection requires a half-face air purifying respirator with high efficiency disposable P100 filter cartridges.
- □ Disposable clothing coveralls, disposable Tyvek suits are commonly used
- □ Safety glasses should be mandatory on all jobs
- Hearing protection
- Hard hats
- Steel toed shoes, disposable Tyvek covers for footwear
- Gloves

Commonly Used Bulk Sampling Equipment

- Ladder
- Flashlight
- Sampling containers
- Spray mist bottle with amended water
- Drop cloths
- □ Cutting tools utility knife
- Caulking gun and compound
- Spray acrylic or adhesive
- Roofing patch compounds
- Duct tape, pre-moistened cloths
- HEPA vacuum (if available)
- □ Indelible ink pen
- Camera
- Measuring devices for small and large areas
- Hammer and chise!
- Pliers

Commonly used administrative supplies

- Inspection forms / field sheets
- Chain of custody forms
- Packing forms
- Plastic bags
- Pens

Appendix B

Examples of Typical Field Sheets Utilized

ASBESTOS BULK SAMPLE FORM

Client: Date: Material Description Anarcial Category SACM TSIACM MACM WACM WACM TOTAL CACHION TOTAL CA	Floor: Job No.	r Friable Type Daniage Access Influence of Influence of Overall Recom- Daniage Severity and Vibration Air Exosion Potential mended Distribution Action	YES DETER UNDAM. LOW LOW LOW ORM	NO WATER DAM MED MED MED MED REMOVE	PHYS. SIG. DAM HIGH HIGH HIGH HIGH REPAIR	NONE LOCAL ENCLOSE	
SACM TSIACM MACM MACM	Building.: Inspector:	Sample Number	©.				
SA ST MA					<u> </u>		
(1) (2) (3) (4)			SACM	TSIACM	MACM		TTS:

INSPECTORS:



TETRA TECH

STANDARD OPERATING PROCEDURES

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Applicability

Tetra Tech, Inc.

Prepared

Earth Sciences Department

Subject DIRECT PUSH TECHNOLOGY (GEOPROBE®/HYDROPUNCH™)

Approved

J. Zimmerly

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1.0 PURPOSE

The purpose of this procedure is to provide general reference information on Direct Push Technology (DPT). DPT is designed to collect soil, groundwater, and soil gas samples without using conventional drilling techniques. The advantage of using DPT over conventional drilling includes the generation of little or no drill cuttings, sampling in locations with difficult accessibility, reduced overhead clearance requirements, no fluid introduction during probing, and typical lower costs per sample than with conventional techniques. Disadvantages include a maximum penetration depth of approximately 15 to 40 feet in dense soils (although it may be as much as 60 to 80 feet in certain types of geological environments), reduced capability of obtaining accurate water-level measurements, and the inability to install permanent groundwater monitoring wells. The methods and equipment described herein are for collection of surface and subsurface soil samples and groundwater samples. Soil gas sampling is discussed in SOP SA-2.4.

2.0 SCOPE

This procedure provides information on proper sampling equipment and techniques for DPT. Review of the information contained herein will facilitate planning of the field sampling effort by describing standard sampling techniques. The techniques described shall be followed whenever applicable, noting that site-specific conditions or project-specific plans may require adjustments in methodology.

3.0 GLOSSARY

<u>Direct Push Technology (DPT)</u> - DPT refers to sampling tools and sensors that are driven directly into the ground without the use of conventional drilling equipment. DPT typically utilizes hydraulic pressure and/or percussion hammers to advance the sampling tools. A primary advantage of DPT over conventional drilling techniques is that DPT results in the generation of little or no investigation derived waste.

<u>Geoprobe7</u> - Geoprobe7 is a manufacturer of a hydraulically-powered, percussion/probing machines utilizing DPT to collect subsurface environmental samples. Geoprobe7 relies on a relatively small amount of static weight (vehicle) combined with percussion as the energy for advancement of a tool string. The Geoprobe7 equipment can be mounted in a multitude of vehicles for access to all types of environmental sites.

<u>HydroPunch</u> ϑ - HydroPunch ϑ is a manufacturer of stainless steel and Teflon7 sampling tools that are capable of collecting representative groundwater and/or soil samples without requiring the installation of a groundwater monitoring well or conventional soil boring. HydroPunch ϑ is an example of DPT sampling equipment.

<u>Flame Ionization Detector (FID)</u> - A portable instrument for the measurement of many combustible organic compounds and a few inorganic compounds in air at parts-per million levels. The basis for the detection is the ionization of gaseous species utilizing a flame as the energizing source.

<u>Photo Ionization Detector (PID)</u> - A portable instrument for the measurement of many combustible organic compounds and a few inorganic compounds in air at parts-per million levels. The basis for the detection is the ionization of gaseous species utilizing ultraviolet radiation as the energizing source.

4.0 RESPONSIBILITIES

<u>Project Manager</u> - The Project Manager is responsible for selecting and/or reviewing the appropriate DPT drilling procedure required to support the project objectives.

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<u>Field Operations Leader (FOL)</u>- The FOL is primarily responsible for performing the DPT in accordance with the project-specific plan.

5.0 SOIL SAMPLING PROCEDURES

5.1 <u>General</u>

The common methodology for the investigation of the vadose zone is soil boring drilling and soil sampling. However, drilling soil borings can be very expensive. Generally the advantage of DPT for subsurface soil sampling is the reduced cost of disposal of drilling cuttings and shorter sampling times.

5.2 Sampling Equipment

Equipment needed for conducting DPT drilling for subsurface soil sampling includes, but is not limited to, the following:

- Geoprobe[®] Sampling Kit
- Cut-resistant gloves
- 4-foot x 1.5-inch diameter macrocore sampler
- Probe sampling adapters
- Roto-hammer with 1.5-inch bit
- Disposable acetate liners for soil macrocore sampler
- Cast aluminum or steel drive points
- Geoprobe® AT-660 Series Large Bore Soil Sampler, or equivalent
- Standard decontamination equipment and solutions

For health and safety equipment and procedures, follow the direction provided in the Safe Work Permit in Attachment 1, or the more detailed directions provided in the project's Health and Safety Plan.

5.3 DPT Sampling Methodology

There are several methods for the collection of soil samples using DPT drilling. The most common method is discussed in the following section. Variations of the following method may be conducted upon approval of the Project Manager in accordance with the project-specific plan.

- Macrocore samplers fitted with detachable aluminum or steel drive points are driven into the ground using hydraulic pressure. If there is concrete or pavement over a sampling location, a Roto-hammer is used to drill a minimum 1.5-inch diameter hole through the surface material. A Roto-hammer may also be used if very dense soils are encountered.
- The sampler is advanced continuously in 4-foot intervals or less if desired. No soil cuttings are generated because the soil which is not collected in the sampler is displaced within the formation.
- The sampler is retracted from the hole, and the 4-foot continuous sample is removed from the outer coring tube. The sample is contained within an inner acetate liner.
- Attach the metal trough from the Geoprobe® Sampling Kit firmly to the tail gate of a vehicle. If a vehicle with a tail gate is not available, secure the trough on another suitable surface.
- Place the acetate liner containing the soils in the trough.

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- While wearing cut-resistant gloves (constructed of leather or other suitable material), cut the acetate liner through its entire length using the double-bladed knife that accompanies the Geoprobe[®] Sampling Kit. Then remove the strip of acetate from the trough to gain access to the collected soils. Do not attempt to cut the acetate liner while holding it in your hand.
- Field screen the sample with an FID or PID, and observe/examine the sample (according to SOP GH-1.3). If appropriate, transfer the sample to sample bottles for laboratory analysis. If additional volume is required, push an additional boring adjacent to the first and composite/mix the same interval. Field compositing is usually not acceptable for sample requiring volatile organics analysis.
- Once sampling has been completed, the hole is backfilled with bentonite chips or bentonite cement grout, depending upon project requirements. Asphalt or concrete patch is used to cap holes through paved or concrete areas. All holes should be finished smooth to existing grade.
- In the event the direct push van/truck cannot be driven to a remote location or a sampling location with difficult accessibility, sampling probes may be advanced and sampled manually or with air/electric operated equipment (e.g., jack hammer).
- Sampling equipment is decontaminated prior to collecting the next sample.

6.0 GROUNDWATER SAMPLING PROCEDURES

6.1 General

The most common methodology for the investigation of groundwater is the installation and sampling of permanent monitoring wells. If only groundwater screening is required, the installation and sampling of temporary well points may be performed. The advantage of temporary well point installation using DPT is reduced cost due to no or minimal disposal of drilling cuttings and well construction materials, and shorter installation/times sampling.

Two disadvantages of DPT drilling for well point installation are:

- In aquifers with low yields, well points may have to be sampled without purging or development.
- If volume requirements are high, this method can be time consuming for low yield aquifers.

6.2 Sampling Equipment

Equipment needed for temporary well installation and sampling using DPT includes, but is not limited, to the following:

- 2-foot x 1-inch diameter mill-slotted (0.005 to 0.02-inch) well point
- Connecting rods
- Roto-hammer with 1.5-inch bit
- Mechanical jack
- 1/4-inch OD polyethylene tubing
- 3/8-inch OD polyethylene tubing
- Peristaltic pump
- Standard decontamination equipment and solutions

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6.3 <u>DPT Temporary Well Point Installation and Sampling Methodology</u>

There are several methods for the installation and sampling of temporary well points using DPT. The most common methodology is discussed below. Variations of the following method may be conducted upon approval of the Project Manager in accordance with the project specific plan.

- A 2-foot x 1-inch diameter mill-slotted (0.005 to 0.02-inch) well point attached to connecting rods is driven into the ground to the desired depth using a rotary electric hammer or other direct push drill rig. If there is concrete or pavement over a sampling location, a Roto-hammer or electric coring machine is used to drill a hole through the surface material.
- The well point will be allowed to equilibrate for at least 15 minutes, after which a measurement of the static water level will be taken. The initial measurement of the water level will be used to assess the amount of water which is present in the well point and to determine the amount of silt and sand infiltration that may have occurred.
- The well point will be developed using a peristaltic pump and polyethylene tubing to remove silt and sand which may have entered the well point. The well point is developed by inserting polyethylene tubing to the bottom of the well point and lifting and lowering the tubing slightly while the pump is operating. The pump will be operated at a maximum rate of approximately 2 liters per minute. After removal of sediment from the bottom of the well point, the well point will be vigorously pumped at maximum capacity until discharge water is visibly clear and no further sediments are being generated. Measurements of pH, specific conductance, temperature, and turbidity shall be recorded every 5 to 10 minutes during the purging process. After two consistent readings of pH, specific conductance, temperature and turbidity (∀10 percent), the well may be sampled.
- A sample will be collected using the peristaltic pump set at the same or reduced speed as during well development. Samples (with the exception of the samples to be analyzed for volatile organic compounds, VOCs) will be collected directly from the pump discharge. Sample containers for VOCs will be filled by (first shutting off the pump) crimping the discharge end of the sample tubing when filled, removing the inlet end of the sample tubing from the well, suspending the inlet tubing above the vial, and allowing water to fill each vial by gravity flow.
- Once the groundwater sample has been collected, the connecting rods and well point will be removed from the hole with the direct push rig hydraulics. The hole will be backfilled with bentonite chips or bentonite cement grout, depending upon project requirements. Asphalt or concrete patch will be used to cap holes through paved or concrete areas. All holes will be finished smooth to existing grade.
- In the event the direct push van/truck cannot be driven to a remote location or sampling location with difficult accessibility, sampling probes may be advanced and sampled manually or with air/electric-operated equipment (e.g., jack hammer).
- Decontaminate the equipment before moving to the next location.

7.0 RECORDS

A record of all field procedures, tests, and observations must be recorded in the field logbook, boring logs, and sample log sheets, as needed. Entries should include all pertinent data regarding the investigation. The use of sketches and field landmarks will help to supplement the investigation and evaluation.

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	ATTACHMENT 1 K PERMIT FOR DPT OPERATIO	NS
Permit No Date:	Time: From	to
•		
III. Field Crew:		
IV. On-site Inspection conducted Y	·	Tetra Tech
V. Protective equipment required Level D Level B Level A Detailed on Reverse Level D Minimum Requirements: Sleeved sl hard hats, and hearing protection will be worn	Respiratory equipment Full face APR Half face APR SKA-PAC SAR Skid Rig nirt and long pants, safety footwear,	Escape Pack SCBA Bottle Trailer None and work gloves. Safety glasses.
Modifications/Exceptions. VI. Chemicals of Concern	Action Level(s)	Response Measures
VII. Additional Safety Equipment/Proced Hard-hat	Yes ☐ No Hearing Protect Yes ☐ No Safety belt/harn Yes ☒ No Radio Yes ☒ No Barricades Yes ☐ No Gloves (Type -	☐ Yes ☒ No ☐ Yes ☐ No ☐ Yes ☐ No ☐ Yes ☐ No egimen ☐ Yes ☐ No
VIII. Procedure review with permit accept Safety shower/eyewash (Location & Daily tail gate meetings	ors Yes NA Use)	Yes NA cy alarms
Contractor tools/equipment/PPE insp IX. Site Preparation	pected Assembly	y points
Utility Clearances obtained for areas Physical hazards removed or blocka Site control boundaries demarcated/	ded	☐ Yes ☐ No ☐ Yes ☐ No ☐ Yes ☐ No
X. Equipment Preparation Equipment drained/depressurized Equipment purged/cleaned Isolation checklist completed Electrical lockout required/field sw Blinds/misalignments/blocks & ble Hazardous materials on walls/beh	vitch tested eeds in placeind liners considered	Yes NA
XI. Additional Permits required (Hot wor If yes, complete permit required or co	k, confined space entry)ontact Health Sciences, Pittsburgh Oi	☐ Yes ☐ No ffice
XII. Special instructions, precautions:	-	

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22 SOUTH LINDEN STREET DUQUESNE, PA 15110 (412) 469-9331 FAX (412) 469-9336 WWW.KURESOURCES.COM

May 31, 2013

Mr. Humberto Monsalvo U.S. EPA, Region 3 1650 Arch Street, 3HS51 Philadelphia, PA 19103-2029

Re:

Programmatic Quality Assurance Plan

Turtle Creek Valley Council of Governments Brownfields Program

Cooperative Agreement #BF-963207-01-0

Dear Mr. Monsalvo:

KU Resources, Inc. (KU Resources) is pleased to provide the United States Environmental Protection Agency (U.S. EPA) with a complete electronic copy of the programmatic Quality Assurance Plan (QAPP) developed for the Turtle Creek Valley Council of Government's Brownfields Assessment Grant program. Upon receipt of the U.S. EPA's comments, we will finalize the QAPP to serve as programmatic guidance documents associated with the implementation of Phase I/II Environmental Site Assessments.

Please contact KU Resources at (412) 469-9331 if you have any questions concerning this report, or the Turtle Creek Valley Council of Government's Brownfields program in general.

Sincerely,

Mark A. Patrick Project Manager

Enclosure

cc: Amanda Settelmaier. Turtle Creek Valley Council of Governments

TURTLE CREEK VALLEY COUNCIL OF GOVERNMENTS PROGRAMMATIC QUALITY ASSURANCE PROJECT PLAN

PHASE I AND PHASE II ENVIRONMENTAL SITE ASSESSMENTS MULTIPLE PROPERTIES ALLEGHENY COUNTY, PENNSYLVANIA COOPERATIVE AGREEMENT #BF-963207-010

Prepared for:
TURTLE CREEK VALLEY COUNCIL OF GOVERNMENTS
2700 MONROEVILLE BOULEVARD
MONROEVILLE, PENNSYLVANIA 15146

MAY 2013



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ATTACHMENT

ATTACHMENT A Standard Operating Procedures for Field Investigations



TCVC13126QAPP A.4

Title and Approval Page

Quality Assurance Project Plan
Phase I and Phase II Environmental Site Assessments
Multiple Properties
Allegheny County, Pennsylvania

Prepared by:
KU Resources, Inc.
22 South Linden Street
Duquesne, Pennsylvania 15110
412-469-9331

May 2013

Cooperative Agreement #BF-963207-01-0

Cooperative Agreement Recipient:	<u>) manda Jettelmacès</u> Signature
	Olghatai o
	Amanda Settelmaier, Executive Director
	() Printed Name/Date
Project Quality Assurance Officer	: Sup / Nerl
•	Signature
	Stephen Pesch
	Printed Name/Date
U.S. EPA Project Manager	
	Signature
	Humberto Monsalvo
	Printed Name/Date



Distribution List

Amanda Settelmaier Executive Director Turtle Creek Valley Council of Governments 2700 Monroeville Boulevard Monroeville, PA 15146

Mark Urbassik, P.E., Principal Mark Patrick, Grant Administrator Stephen Pesch, Project Manager/QA Officer KU Resources, Inc. 22 South Linden Street Duquesne, PA 15110

Humberto J. Monsalvo, Jr. (3HS23) U.S. Environmental Protection Agency Region 3 1650 Arch Street Philadelphia, PA 19103-2029



INTRODUCTION

This Quality Assurance Project Plan (QAPP) has been developed for multiple Phase I and II Environmental Site Assessments (ESAs) to be performed for the Turtle Creek Valley Council of Governments (TCVCOG) at various brownfields site locations within Allegheny County, Pennsylvania. This QAPP contains specific procedures to be followed so that proper documentation of sampling procedures, field measurements, and sample analyses will produce representative and valid chemical quality data during all sampling activities. Conditions encountered at the sites may require some variation in this program that will be documented and will, for future site activities, be addressed in any subsequent amendments to this QAPP.

The format of this QAPP is consistent with the U.S. EPA Region III Brownfields Quality Assurance Project Plan Template, Interim Final, dated March 2001; and Region III QAPP Preparation Checklist dated April 30, 2001. Pursuant to this guidance and the associated checklist, the following technical elements are included in the QAPP:

- Project Management (Sections A.1 through A.5);
- Measurement/Data Acquisition (Sections B.1 through B.10);
- Assessment and Oversight (Sections C.1 and C.2); and
- Data Validation and Usability (Sections D.1 through D.3).

Standard Operating Procedures (SOPs) for Phase II ESA field investigation are included as Attachment A.



A. PROJECT MANAGEMENT

A.1 Project Organization and Responsibility

This section provides an outline of the conceptual management approach for the TCVCOG's brownfields program. This Project Organization has been designed to meet the following goals:

- Ensure adherence to the technical and other performance requirements of the QAPP;
- Provide a central point of contact concerning all technical functions; and
- Provide a coordinated management framework for implementing the technical approach, safety program, QA, and data and technical information exchanges.

The technical management structure to be employed during this project provides for several levels of project management. Figure A-1 presents an organization chart of the project participants. The role of each participant is described below:

- TCVCOG, Executive Director, Amanda Settelmaier: primary contact for the Cooperative Agreement Recipient, overall program direction.
- Project Director, Mark Urbassik, PE: overall responsibility for the financial and administrative performance of the program, and for peer review of project work products.
- Project Manager/QA Officer, Stephen Pesch: overall responsibility for the technical performance
 of the program including oversight of field investigation activities, QA/QC, compilation of data, and
 evaluation/interpretation of results.
- Grant Administrator, Mark Patrick: overall responsibility for the administration of the grant program including preparing and submitting quarterly reports, in coordination with TCVCOG and U.S. EPA.
- Principal Investigator, Stephen Pesch or alternate: responsible for conducting field investigations, overseeing the compilation of field data, and assisting with the evaluation of results.
- Analytical Laboratory (laboratory will be selected on a project-specific basis): responsible for providing sample containers and analytical/reporting services pursuant to the QAPP and sitespecific Phase II ESA Sampling and Analysis Plans (SAPs).

It is the responsibility of the Project Manager to implement the management approach described in this QAPP. The Project Manager will rely upon the Principal Investigator for the day-to-day technical management of specific site investigations. The Principal Investigator will inform and direct the other team members about specific technical issues and protocols that are applicable to the QAPP.



The project management structure described herein provides for implementation of the QA/QC program and health and safety protocols.

A.2 Project Strategy

The purpose of this project is to implement the TCVCOG's United States Environmental Protection Agency (U.S. EPA) Brownfield Assessment Cooperative Agreement, generally entailing the performance of Phase I and Phase II ESAs to be performed for multiple sites located within Allegheny County, Pennsylvania. The information obtained via the Phase I and Phase II ESA process will then be utilized to develop integrated cleanup and redevelopment plans for designated sites selected by the TCVCOG.

The funding for this project is being provided by the TCVCOG's 2012 \$600,000 U.S. EPA Brownfield Assessment Grant Program. Program activities will be initiated in 2013, and the program implementation is expected to require approximately 3 years.

A.2.1 Phase I ESAs

A Phase I ESA represents the initial environmental assessment of a brownfields property, and generally entails the non-intrusive (i.e., no sampling/analysis) review of information for the property which is being assessed, as well as the surrounding properties. Phase I ESA sites will be selected by the TCVCOG, based upon the TCVCOG's Cooperative Agreement Work Plan, and brownfield inventorying activities conducted by KU Resources. Property Approval Questionnaires will be prepared and submitted for U.S. EPA review and approval prior to initiating Phase I ESA activities.

The purpose of the Phase I ESA process is to review multiple information sources regarding historical site usage or industrial practices which may have resulted in identified or potential environmental concerns. In addition to the review of multiple informational sources, local regulators or other personnel knowledgeable of the site's history may be contacted. A site visit is then conducted to visually inspect the property, buildings, and adjacent land for evidence of current or past uses which may pose a "recognized environmental condition" (REC) as defined by the ASTM International (ASTM) Standard E 1527-05, "Standard Practices for Environmental Site Assessments — Phase I Process."

The results of these efforts are then presented in a Phase I ESA report. The findings of the Phase I ESA may indicate the need for a more detailed and/or intrusive assessment such as sampling and analysis of certain environmental or building media. In such a case, the implementation of a Phase II ESA may be required in order to confirm the presence of environmental concerns and subsequently delineate and quantify the areas of environmental concern.

A.2.2 Site-Specific Phase II ESA SAPs

For sites warranting Phase II ESA activities and which have been approved for Phase II ESA activities by the TCVCOG, a Property Profile Form will be prepared and submitted for U.S. EPA review and funding approval. Upon receiving U.S. EPA approval for Phase II activity, a Site-Specific Phase II ESA SAP will then be developed to identify the specific intrusive investigation activities planned to further characterize the environmental condition of a site. The individual SAPs serve as companion documents to the



programmatic QAPP, and are intended to provide the site background, project description, sampling/ analysis scope and methodology, schedule, and other pertinent factors associated with individual Phase II ESA sites.

The format of the SAPs will be consistent with the latest available Region III guidance (Site-Specific Sampling and Analysis Plan Template, Draft Interim Final, August 1999), with the following outline:

A. PROJECT MANAGEMENT

- A1 Site Information/Background
- A2 Project Design
- A3 Project Timeline
- A4 Measurement Quality Objectives

B. MEASUREMENT/DATA ACQUISITION

- **B1** Sample Design
- **B2** Sampling Methods Requirements
- B3 Analytical Methods Requirements

C. DATA USABILITY

C1 Reconciliation with User Requirements

In accordance with U.S. EPA requirements, SAPs will be submitted to the U.S. EPA at least 30 days before the initiation of any Phase II investigations. The U.S. EPA approval of the SAP will be obtained prior to the initiation of sampling and analysis activities.

A.2.3 Phase II ESAs

Upon receipt of the approval of the SAP, the planning and implementation of the Phase II ESA will be initiated. The purpose of a Phase II ESA is to further evaluate the RECs identified for a particular brownfields site via the Phase I ESA process. The Phase II ESAs will involve sampling and analysis of the various environmental and building media which could be impacted by the RECs identified during the Phase I ESA, possibly inclusive of surface soil, subsurface soil, groundwater, surface water, sediments, soil vapor, building, and waste materials.

Laboratory analyses will be performed by a laboratory that has been certified by the National Environmental Laboratory Accreditation Conference (NELAC).

Upon completion of the Phase II ESA field activities and the receipt of the analytical results, Phase II ESA reports will be prepared to document the results of the site assessment activities. The Phase II ESA reports will include all relevant information and supporting documentation, including but not limited to sample locations, sample results, comparison with applicable regulatory screening values, laboratory



analytical reports, etc. A copy of all Phase II ESA reports prepared under the TCVCOG's grant program will be provided to the U.S. EPA upon completion.

A.3 Quality Objectives and Criteria

The overall QA objective for the site characterization process is to provide procedures which, when followed properly, will provide assurance that reasonable decisions based on laboratory and field data generated during the investigations are technically sound, statistically valid, and properly documented. Data will ultimately be used to determine if a threat to public health or the environment exists, and to assist in formulating remediation strategies and determining disposal options.

Data generated by the investigations will be compared to those values associated with the Pennsylvania Department of Environmental Protection's Land Recycling and Environmental Remediation Standards Act (commonly referred to as "Act 2"). Specific procedures to be utilized for sampling, laboratory analyses, data reporting, and data validation are presented in other sections of this QAPP.

The primary purpose of this section of the QAPP is to define statistical acceptance of criteria for chemical data generated by the analytical laboratory. These statistically-based criteria are referred to in this document as Data Quality Objectives (DQO) and are expressed in terms of precision, accuracy, completeness, representativeness, and comparability.

A.3.1 Precision

Precision is defined as the degree of agreement between repeated measurements of the same parameter under prescribed, similar conditions. Field and laboratory precision will be monitored using results from replicate/duplicate sample analyses. Precision can be expressed as the relative percent difference (RPD) of one result with another. The RPD is calculated as follows:

RPD =
$$\frac{D1 - D2}{[D1 + D2]/2}$$
 = 100 percent

where,

RPD = Relative Percent Difference

D1 = First Duplicate Value

D2 = Second Duplicate Value

The overall DQO for precision of analytical measurement is expressed as a percent of the duplicate having RPDs within established control limits.

A.3.1.1 Field Precision

The precision of field measurements will be evaluated through the analysis of replicate measurements. Generally, during water sampling activities, measurements of pH, specific conductance, and temperature will be performed at least three times on different aliquots of water. Selected soil samples may be



screened in the field for the presence of organic vapors by performing headspace analyses on sample containers. However, because soil matrices are often heterogeneous, a good precision is often unattainable. To minimize this effect, attempts will be made to collect homogeneous (i.e., to the maximum degree possible) replicate samples for organic vapor screening.

A.3.1.2 Laboratory Precision

Precision performance requirements for all chemical analyses performed by the analytical laboratory have been established. The analytical laboratory will assess precision by performing duplicate analyses on select samples at a frequency concurrent with methodology specifications.

A.3.2 Accuracy

Accuracy is the measure of the degree of agreement between an analyzed value and the true or accepted value where it is known. Field and laboratory accuracy will be monitored using standards of known concentrations or values spiked into select samples. Accuracy can then be expressed as a percent recovery (%R), which is calculated as follows:

%R = Qd/Qa x 100 percent

where,

Qd = Spiked sample result minus the sample result

Qa = Spike amount

Thus, the overall DQO for accuracy is the percent of samples having %R within prescribed control limits.

A.3.2.1 Field Accuracy

The accuracy of data produced by field instruments will be maintained and documented by performing initial calibrations followed by continuing calibration verifications and/or continuing calibrations with known standards in accordance with specified SOPs found in Attachment A.

A.3.2.2 Laboratory Accuracy

Measures to be taken by the analytical laboratory to ensure accuracy include instrument tuning, instrument calibrations (initial and continuing), analyses of laboratory standards, and analyses of independent QC samples supplied by the U.S. EPA or traceable to the National Bureau of Standards (NBS).

A.3.3 Completeness

Completeness is a measure of the amount of valid data obtained from an analytical measurement system. It is expressed as a percent of the overall data that were generated and is calculated as follows:

 $C = V/T \times 100$ percent



where,

C = percent completeness

V = number of measurements judged valid

T = total number of measurements

It is anticipated that 100 percent of the proposed samples can be collected. It is expected that the laboratory will provide data meeting QC completeness criteria for at least 90 percent of the samples analyzed.

A.3.3.1 Field Completeness

Field measurements including pH, specific conductance, temperature, oxygen release potential (ORP), turbidity, and headspace volatile organic screenings will be taken where applicable. To ensure the completeness of the data generated from these measurements, calibration logs will be maintained for each instrument. In turn, these measurements will provide an indication of whether any measurements were made with instruments that were not calibrated or functioning properly.

A.3.3.2 Laboratory Completeness

Control limits for all chemical analyses performed within the analytical laboratory have been established. Analyses not meeting specified control limits for a particular analysis will be flagged. It is expected that the laboratory will provide data meeting QC completeness criteria for at least 90 percent of the samples analyzed.

A.3.4 Representativeness

Representativeness is understood to be a sample or set of samples that provide a typical example of general groundwater or soil quality in a given area of concern. Sampling locations (specified in the individual site-specific SAPs) will be selected to provide detailed chemical information for areas of concern. Chemical parameter analyses (also specified in the individual site-specific SAPs) will be selected based on knowledge of the site history and results from previous investigations, and will provide adequate chemical characterization of areas of concern.

A.3.4.1 Field Representativeness

During the soil boring program, selected samples may be screened in the field for the presence of headspace volatile organics. Headspace readings will be recorded and will be included on boring logs. Appropriate sample handling and equipment decontamination procedures will be followed to ensure that representative samples are collected. Any material thought to be associated with sloughing will not be included with the soil samples.

During the groundwater sampling events, pH, specific conductance, ORP, turbidity, and temperature will be recorded during development, purging, and sampling to facilitate, to the maximum extent possible, the collection of groundwater quality samples.



A.3.4.2 Laboratory Representativeness

The representativeness of laboratory-generated data will be maintained through careful sample preparation techniques and sample tracking procedures.

A.3.5 Comparability

Comparability, as used in this referenced QAPP, is defined as the similarity of one unit of measure to another unit of measure. Results from chemical analyses associated with the individual project and performed either in the laboratory or in the field will be reported in similar units to existing site data, to the extent possible.

A.4 Special Training/Certification

There are no special training/certification requirements for the investigative work to be performed. The project team is highly experienced in the performance of Phase I and Phase II ESAs, and in the use of the equipment to be used for the Phase II ESA fieldwork.

As discussed in Section A.2.3, the analytical laboratory will be NELAC-certified.

A.5 Documents and Records

A.5.1 QAPP Distribution and Revision

This QAPP will be distributed to all persons identified on the distribution list. Should any revisions be made to the QAPP, the Project Manager will ensure that these revisions are transmitted to each person identified on the distribution list, along with instructions as to the proper management of the revisions (insertion locations, destruction of superceded pages, etc.).

A.5.2 Sample Location Identification

A sample numbering system will be used to allow tracking, retrieval, and cross-referencing of sample information and positive identification. Each sample submitted for chemical analysis will be assigned a unique sample identification number. The sample identification number will consist of the following: a site location code, a sample matrix code, a sample location code, and (as appropriate) information regarding the sampling depth interval. An example sample identification number is: TCVCOG-SB-01(2-4').

Sample labels will be affixed to each sample at the time of collection. The label will include the following information at a minimum:

- Sample identification number,
- Time and date sampled, and
- Preservatives added (as required).



In addition, each person involved in the sampling activity will record the above information, as well as comments regarding sampling, in a field logbook. This information will be used to complete the chain-of-custody forms for the project.

A.5.3 Documentation of Field and Sampling Activities

The validity of samples collected in the field will be documented by the use of field-written activity records. This documentation, along with chain-of-custody forms, will provide a permanent record of all significant activities completed during the Phase II ESA. Field logs will be completed using waterproof, indelible inks, and water resistant paper.

A.5.3.1 Daily Activity Records

Field data sheets, or a bound field book with sequentially numbered pages, will be maintained during the course of the Phase II ESA to document all field investigation and sampling activities. Records will be inclusive of any significant deviations from the approved SAP, along with an explanation for this deviation.

A.5.3.2 Instrument Calibration and Use Logs

Standardized calibration logs for field instrumentation will be maintained during all sampling activities to document the condition of the equipment. Documentation of time of instrument use, operator, and any maintenance performed will be included on the log.

A.5.3.3 Sampling and Well Logs

Standardized boring logs (geologic logs), well completion logs, and groundwater sampling sheets will be prepared and maintained for samples collected during the project. All sampling logs and field sheets will be completed in the field, reviewed, signed, and dated.

A.5.4 Document Management

The Project Manager is responsible for maintaining original field records that document sampling activities and laboratory analysis records in a central file for future reference. These records should include historical information (data, reports, and maps), current site maps, daily logs, field instrument logs, sampling logs, signed and dated chain-of-custody documentation, field data sheets, bound field books, laboratory correspondence files, laboratory data, field and laboratory data validation notes, and any other information specific to field and laboratory activities not mentioned herein. Laboratory data summaries will be provided in hard copy, with analytical backup documents provided in electronic format. A complete copy of all of the above-mentioned files will be maintained for future reference. It is anticipated that the final evidence file will be retained in perpetuity.



B. MEASUREMENT AND DATA ACQUISITION

B.1 Sampling Process Design

For each Phase II ESA to be performed for the TCVCOG's U.S. EPA Brownfields Program, a site-specific SAP will be prepared that will provide specific details regarding environmental media to be sampled; sampling locations; number, types, and frequency of samples to be collected; and laboratory analyses to be performed (see Section A.2). The SAP will also include background information regarding each area to be investigated, and a supporting rationale for the sample collection and analysis program. A site-specific Health and Safety Plan (HASP) will also be prepared for each Phase II ESA to be performed, to supplement the programmatic HASP with individual project-related safety information (e.g., directions to nearby hospital, site contaminants, etc.).

B.2 Sampling Methods

B.2.1 General Description

Environmental samples to be collected for physical or chemical analysis may consist of soil from soil borings and surface samples; groundwater from monitoring wells; surface water and sediment from seeps/discharges or surface water bodies; and waste materials. The analyses, to be specified in the individual SAPs, will be selected to provide specific data relevant to the identified RECs at the site and the characterization of chemical constituents present. Deviations from the prescribed methodologies and/or specified chemical analyses will be pre-approved by the project manager, as necessary, and will be documented in the project file.

Prior to collecting any environmental samples, several tasks will be performed.

Sample bottles will be pre-cleaned upon arrival from the analytical laboratory. The sample bottles will be pre-cleaned from the manufacturer or by the laboratory itself. Should the bottles be pre-cleaned by the analytical laboratory, the procedure will be as follows:

- 1. Spray or scrub with mild solution of tap water and Liquinox detergent.
- 2. Rinse with copious amount of potable water.
- 3. Rinse with deionized (Reagent Grade II) water.
- 4. Rinse with pesticide-grade methanol.
- 5. Rinse with pesticide-grade hexane.
- 6. Air dry on clean, non-plastic surface in a well-ventilated uncontaminated environment.

The laboratory will be notified of incoming samples to prepare for holding times of specific samples. The sampling equipment required to collect, contain, preserve, and ship the samples will be packaged and organized to allow efficient operation in the field. Field decontamination equipment will also be prepared to enable this work to be performed when required.



The sampling equipment used in the collection for environmental media will be properly decontaminated. This procedure will be applicable for any equipment that will be used for field measurements or to collect a sample for chemical analysis. Field decontamination for all equipment will be as follows:

- 1. Wipe with paper towel or brush to remove grit or visible contamination.
- 2. Spray or scrub with mild solution of tap water and Liquinox (or equivalent) detergent.
- 3. Rinse with copious amounts of potable water.
- 4. Rinse with distilled or deionized water.
- 5. Store in sealed container until re-use.

A general description of how the investigatory activities will be conducted is provided in this section of the QAPP. The universal field and laboratory testing procedures will be performed in accordance with the general procedures described herein, and specific sampling procedures will be detailed in the individual SAPs.

B.2.1.1 Soil Quality Investigation

Surface soil sampling will be performed using a decontaminated trowel, hand auger, direct-push hydraulic sampling unit, or split-spoon sampler. Subsurface soil sampling will be performed using a direct-push hydraulic sampling unit, hand auger, or split-spoon sampler. Upon sample retrieval, the field investigator will log the sample, screen the sample in the field (as appropriate) for organic constituent content using a photoionization detector, and place the appropriate aliquots into sample jars for delivery to the laboratory. Boreholes will be backfilled with native material and/or bentonite clay upon completion of the boring.

Samples may be analyzed for volatile organic compounds (VOCs) (Method 8260B/5035), semi-volatile organic compounds (SVOCs) (Method 8270), target analyte list (TAL) metals (6000- and 7000-series Methods), plus cyanide (Method 9014); and polychlorinated biphenyls (PCBs) (Method 8082). Other analytical methods may be utilized, as needed, based on the potential chemicals of concern for individual sites.

B.2.1.2 Groundwater Quality Investigation

The purpose of groundwater quality investigations is to characterize groundwater quality in the project area, as warranted based on the RECs identified via the Phase I ESA process. Monitoring wells may be installed to characterize site hydrogeologic conditions and groundwater flow directions, as well as to determine groundwater quality in areas upgradient and downgradient of presumed or identified source areas.

Monitoring wells may be installed using direct-push techniques, hollow-stem auger drilling techniques, cable-tool drilling techniques, or air-/mud-rotary drilling techniques, or a combination thereof. The individual SAPs will specify the drilling method(s), based on the site-specific drilling conditions, depth of well settings, equipment access constraints, and other considerations. The SAPs will also specify the monitoring well construction details.



Well development and purge water generated during investigation activities will be collected and retained pending receipt of the laboratory analytical results from the subsequent groundwater monitoring event(s). Following receipt of analytical results, the collected development/purge water will be managed, as appropriate.

Groundwater quality samples may be collected and submitted for laboratory analysis. Groundwater samples may be analyzed for VOCs by Method 8260B, SVOCs by Method 8270, PCBs by Method 8082, and TAL inorganics and cyanide by Method 6000/7000 and Method 9014. TAL inorganics/cyanide samples would be field filtered. Other analytical methods may be utilized, as needed, based on the potential chemicals of concern for individual sites.

B.2.1.3 Surface Water and Sediment Sampling

Surface water and/or sediment samples may be collected from selected surface seeps and/or outfalls, or surface water bodies at or near the individual sites. Samples would be obtained with dedicated sampling equipment, as specified in the site-specific SAPs. Laboratory analyses may include VOCs by Method 8260B, SVOCs by Method 8270, PCBs by Method 8082, and TAL inorganics/cyanide by Methods 6000/7000 and 9014. Other analytical methods may be utilized, as needed, based on the potential chemicals of concern for individual sites.

B.2.1.4 Waste Sampling

Waste samples may be collected from containers, tanks, pits, etc. that could be present at the site. Samples would be obtained with dedicated sampling equipment, as specified in the SAP. Laboratory analyses may include VOCs by Method 8260B, SVOCs by Method 8270, PCBs by Method 8082, and TAL inorganics/cyanide by Methods 6000/7000 and 9014, or other waste characteristics analyses (e.g., toxicity characteristic leaching procedure) to support disposal authorization efforts.

B.2.2 Sampling Procedures

SOPs are provided in Attachment A, which includes a compilation of procedures to be used to collect representative environmental samples and field parameters. These SOPs should be strictly followed to ensure the integrity and validity of each and every sample collected.

B.2.2.1 Soil Sampling

Soil samples will be collected using sampling techniques described in the SOPs included in Attachment A.

Soil samples will be field-classified and shipped to the laboratory for analysis of the required parameters. All observations and pertinent data developed during soil sampling will be recorded in the project field book. At the beginning of each entry, the date and other pertinent information will be entered.

All measurements made and samples collected will be recorded on project field data sheets (or in a bound field book). Wherever a sample is collected or a measurement is made, a detailed description of



the location of the sample will be recorded. The equipment used to make measurements will be identified, along with the date of the last calibration.

Excess soil generated as a result of soil boring and well installation activities will be containerized in sealed, labeled 55-gallon drums, pending review of the laboratory data and waste disposition considerations.

B.2.2.2 Groundwater Sampling

Groundwater samples will be collected using sampling techniques described in the SOPs included in Attachment A.

Prior to implementing a groundwater sampling program, several tasks must be performed. Sample bottles will be pre-cleaned by the supplier, and sampling equipment will be cleaned and packaged for the required sampling. The laboratory will be notified of incoming samples to prepare for holding times of specific samples. The sampling equipment required to collect, contain, preserve, and ship the samples will be packaged and organized to facilitate efficient operation in the field. Field decontamination equipment will also be prepared to enable this work to be performed when required.

Relevant observations made and pertinent data obtained during groundwater sampling will be documented in the project field logbook. At the beginning of each entry, the date and other pertinent information will be entered.

Measurements made and samples collected will be recorded on project field data sheets (or in a bound field book). Wherever a sample is collected or a measurement is made, a detailed description of the location of the station will be recorded. The equipment used to make measurements will be identified, along with the date of the last calibration.

B.2.2.2.1 Water Level Measurements

The depth to the top of water in each monitoring well will be measured and recorded on the field data sheet immediately prior to sampling. All water level measurements will be taken from surveyed points on each well casing and measured to an accuracy of 0.01 foot.

Regardless of the method of water level measurement, the upgradient well(s) should be measured prior to the source area and downgradient wells. When performed in conjunction with decontaminating the measuring device between wells, the potential for cross-contamination will be reduced.

There are several methods that may be used to measure the groundwater levels within wells. The groundwater sampling SOP in Attachment A outlines these procedures.

B.2.2.2.2 Well Development

Development will follow monitoring well construction and will proceed well purging and sampling. Well development is performed to improve the flow of water into the well screen by removing fine particles from



the formation immediately surrounding the screened well so that groundwater can enter the well more freely. In addition, development will remove from the well any potential effects the drilling/construction might have on the physical and chemical characteristics of the groundwater quality samples. Generally, well development is not performed any sooner than 24 hours following installation in order to give the well materials time to settle in place and the bentonite seal time to completely hydrate.

Well development will be accomplished using a pump or bailer to evacuate water from the wells. Progress will be determined by observing changes in clarity and stability in measured water quality field parameters including specific conductivity, pH, and temperature. A minimum of three well volumes will be removed from each monitoring well (as feasible or practical). The measured field parameters, the pumping rate(s) and duration, and volume of groundwater removed will be recorded in the project field book for each well. Evacuated groundwater will be containerized in sealed, labeled 55-gallon drums, pending review of groundwater guality results and waste disposition considerations.

B.2.2.2.3 Well Purging

All monitoring wells will be purged prior to sampling in order to increase the representativeness of the sample. Purging of each well will be performed in accordance with the SOP in Attachment A. Wells will be purged until at least three casing volumes of water are removed from each well, or until the pH, conductivity, and temperature of the purge water has stabilized prior to sampling. The pH, conductivity, and temperature field measurements will be recorded for each well included in the sampling program. The final measurement recorded during the purging process, used to verify the stabilization of the water, shall be considered as part of the data quality record for the well. Low-yielding wells should be purged to clear dryness once, and allowed to recover sufficiently. Except for low-yielding wells that may require additional time to recover, wells will be sampled within three hours of purging.

B.2.2.2.4 Sampling

Wells will be sampled using a peristaltic pump operating at low-flow conditions, or dedicated bailers, as specified in the site-specific SAP.

SOPs for the selected sampling techniques are included in Attachment A.

B.2.2.3 Surface Water, Sediment, and Waste Sampling

Surface water, sediment, and waste samples will be collected using sampling techniques described in the SOPs included in Attachment A. Sampling techniques will depend on site and matrix characteristics, and will be specified (as appropriate) in the site-specific SAP.

Prior to collecting these samples, several tasks will be performed. Sample bottles will be pre-cleaned (as appropriate) and equipment will be cleaned and prepared for the required sampling. The laboratory will be notified of incoming samples to prepare for holding times of specific samples. All of the sampling equipment required to collect, contain, preserve, and ship the samples will be packaged and organized to allow efficient operation in the field. Field decontamination equipment will also be prepared to enable this work to be performed when required.



B.2.2.4 Soil Gas Sampling

Soil gas samples may be collected using sampling techniques described in the SOPs included in Attachment A.

Sampling techniques and analytical parameters will depend on the site history and matrix characteristics, and will be specified (as appropriate) in the site-specific SAP.

B.2.2.5 Sample Containers

All samples sent to the laboratory for chemical analyses will be placed in new containers provided by the analytical laboratory. The laboratory will ship these containers to a specified location along with bottle custody forms, a brief explanation of designated bottle use, and packing materials to prevent bottle breakage. Containers for field screening parameters (headspace volatiles, pH, specific conductance, and temperature) will also be provided by the laboratory.

B.2.2.6 Sample Preparation

Groundwater samples sent to the laboratory for TAL metals/cyanide analyses will be field filtered through 0.45-micron membranes according to the SOP outlined in Attachment A.

As applicable, soil samples collected from on-site soil borings will be split between two sample jars, as described in Attachment A. One of the jars will be used for screening for headspace VOCs, while the other will be prepared for shipment to the analytical laboratory for chemical analyses. Sample preservation techniques to be followed for all sample matrices are described in the SOP.

B.3 Sample Handling and Custody

Specific and consistent sample custody procedures will be followed to preserve sample integrity and to ensure the validity of analytical results. All sample data will be traceable from the time and location of sample collection through analyses and final use of the data.

B.3.1 Sample Container Custody

All containers will remain in the custody of the laboratory until received by a representative of the sampling team, and will be shipped from the laboratory by common carrier in sealed coolers to the designated location prior to sampling. The laboratory will provide a shipping form listing all containers shipped and specify the purpose of each.

B.3.2 Field Activity Custody Procedures

Prior to sampling at a given location, appropriate sample containers will be selected, and the sample identification number will be recorded on the sample log form. Sample containers will then be labeled with the following information: project code number, sampling date and time, sample identification number, parameters of interest, preservative, and initials of sampling personnel.

Once sampling activities commence, written logs will be maintained using the prescribed sample identification system described previously.



B.3.3 Sample Custody and Shipping

For the purpose of this project, a sample is considered in custody if it is:

- In actual possession of the responsible person;
- In view, after being in physical possession;
- Secured so that no one can tamper with it after having been in physical custody; or
- In a secured area, restricted to authorized personnel after being in physical possession.

Sample chain of custody and shipping will be performed consistent with the SOPs included in Attachment A.

Upon transfer of custody, the chain-of-custody form will be marked with the time and date followed by the sample custodian's (i.e., sender's) signature. Since common carriers (Federal Express, Airborne Express, UPS, etc.) will not sign chain-of-custody forms, the chain-of-custody records will be sealed in plastic bags within each cooler. All chain-of-custody forms, when received by the laboratory, must be signed and dated by the laboratory sample custodian and returned to the designated recipients in a timely manner.

B.3.4 Laboratory Chain of Custody

At the time of sample cooler receipt, the laboratory sample custodian will note the condition of each sample, as well as questions or observations concerning sample integrity. The sample custodian will also maintain a sample tracking record that will follow each sample through all stages of laboratory processing and analyses. The sample tracking records must indicate date of sample receipt, extraction or preparation, if applicable, and sample analysis. These records will be used to evaluate holding time limits.

B.4 Analytical Methods

All methods for chemical analyses will be performed in accordance with SW-846 Test Methods for Evaluating Solid Waste – Physical Chemical Methods. Laboratory analyses will be performed by a laboratory that has been certified by NELAC. Prior to submitting samples for analysis under the individual SAPs, the laboratory's list of certified methods, and practical quantitation limits and method detection limits for each analytical parameter to be performed will be obtained. Analytical packages will be provided by the laboratory in electronic format, for inclusion with the individual Phase II ESA reports.

Field parameters (pH, specific conductance, temperature, and headspace VOCs) will be measured according to specific instrument manufacturer's instructions. A summary of these methods is presented in Attachment A.

B.5 Quality Control

In addition to internal QC checks performed by the selected laboratory, QC for sampling procedures and laboratory analyses will also be conducted. These checks will consist of the preparation and submittal of sample (equipment) rinsate blanks/field blanks at a frequency of greater than or equal to one per 20



samples collected. Field duplicates will be collected at a frequency of greater than or equal to one sample for each 20 collected for groundwater samples, and at a frequency of greater than or equal to one sample for each 20 collected for soil samples. Trip (travel) blanks will be placed in a representative cooler with each shipment to accompany samples collected for volatile organic analysis. Temperature blanks will be placed in all coolers sent to the laboratory.

The above-mentioned field QC blanks and replicates included as internal QC checks are defined as follows:

Equipment (Rinsate) Blank: This QC blank will be made by taking organic-free distilled water and placing it in contact with the field sampling apparatus (bailer, pump tubing, split-spoons, etc.) or with the air near a well that conceivably could be a source of contamination. The water will then be sealed in the same type of sample bottle as the other samples, preserved in the same manner, transported to the laboratory with other samples, and analyzed for the parameters of interest.

<u>Field Blank</u>: This will be completed by filling sample containers in the field with organic-free deionized or distilled water that will be prepared and preserved in the same manner as the samples. The field blank will be transported to the laboratory with other samples and analyzed along with field samples for the constituents of interest to check for contamination imparted by the sample container, preservative, or other exogenous sources.

<u>Trip Blank:</u> Trip (or travel) blank will be prepared by filling a sample container in the laboratory with organic-free water. This sample will travel unopened with the sample bottles. It will be returned unopened with other field samples to the laboratory where it is opened and analyzed with the field samples for volatile organic constituents.

<u>Field Duplicate (Replicate)</u>: Both the duplicate and the sample are collected at the same time and will be prepared at the sampling location in equal portions in the same manner, preserved in the same way, and analyzed by the same laboratory as a measure of sampling and analytical precision.

<u>Temperature Blank:</u> Temperature blanks will be prepared by filling a sample container in the laboratory with water. This sample will travel unopened with other field samples to the laboratory where it will be opened and the temperature will be measured.

B.6 Instrument/Equipment Testing, Inspection, and Maintenance

Field and laboratory equipment that may require preventative maintenance will be serviced as described in the Operator's Manual for each instrument. A record of calibration and maintenance activities for each piece of equipment will be maintained in logbooks.



B.7 Instrument/Equipment Calibration and Frequency

To meet the DQO for this project, proper calibration procedures for all instrumentation must be followed. This applies to field and laboratory instruments. The following provides calibration information for field and laboratory instrumentation along with required recalibration criteria and frequency.

B.7.1 Field Instrumentation

General procedures for the calibration of field equipment for measurement of pH, specific conductance, and headspace VOCs that will be employed for this project are provided in the Operator's Manual for each instrument. Initial calibrations should be performed at the beginning of each workday. Continuing calibrations and calibration checks should be performed at a minimum of every two hours.

Criteria triggering recalibration will be based on accuracy and precision requirements specified in the DQO. If the calibration is not within the specified criteria for a given instrument, it must be recalibrated.

B.7.2 Laboratory Instrumentation

Calibration procedures, frequency, and standards for measurement of variables and systems will be employed by the analytical laboratory in accordance with its internal procedures and protocol.

B.8 Inspection/Acceptance of Supplies and Consumables

The Principal Investigator will be responsible for ensuring that field supplies and consumables are suitable for use in the project. All sample containers will be new, and will be provided by the laboratory. Disposable sampling equipment will be new and designated for single use. All non-disposable sampling equipment will be decontaminated and inspected prior to use.

B.9 Non-Direct Measurements

The Site-specific SAPs will be developed, based in part on the results of the Phase I ESAs, to assist in the selection of sampling locations and analytes of interest. Among other things, these Phase I ESAs review regulatory and historical database searches performed for the specific property of interest and a defined radius around that property. Because of the intended use of this information, there are no identified limitations that will be placed on the database reviews.

B.10 Data Management

Field data will be retained in field notebooks, and transcribed onto electronic tables, boring logs, etc. by hand. These entries will be checked by the Principal Investigator or Project Manager to ensure accuracy.

Analytical data will be provided by the laboratory as both a written final report, and as an electronic format compatible with spreadsheet and data management programs (i.e., Microsoft Excel).



C. ASSESSMENT AND OVERSIGHT

C.1 Assessments and Response Actions

Performance and system audits for sampling and analysis operations will consist of on-site review of field and laboratory QA systems and on-site review of equipment for sampling, calibration, and measurement.

C.1.1 Audits

C.1.1.1 Field System Audit

The Project Manager will make one or more non-scheduled visits to the project site to observe the performance of the field operations team during all phases of field activities (soil sampling program, groundwater sampling, etc.).

C.1.1.2 Laboratory System Audit

A laboratory system audit may be conducted at some point prior to or during the course of the project. This audit would be designed to ensure that the systems and operational capabilities are maintained and test methodology and QC measures for the project are being followed.

C.1.1.3 Performance Evaluation Audit

A performance evaluation audit (PEA) is used to evaluate a laboratory's ability to obtain an accurate and precise answer for the analysis of a blind check sample for a specific analytical method. Following any analytical data validation as described in Section D, a PEA of the laboratory may be conducted if it is determined that the QA data provided in the analytical data package for any parameter are outside acceptance criteria control limits. These PEAs may include a review of all raw data developed by the laboratory, but not reported to KU Resources, along with the submission of blind-spiked check samples for the analysis of the parameters in question. These check samples may be submitted and disguised as field samples, in which case the laboratory will not know the purpose of the samples or the samples may be obvious (known) check samples (U.S. EPA or NBS traceable).

PEAs may also be conducted by reviewing the laboratory's results from certification testing and/or U.S. EPA Contract Laboratory Program (CLP) evaluation samples. An additional component of PEAs may include the review and evaluation of raw data generated from the analysis of PEA samples and actual field samples that may be in question.

C.1.1.4 Regulatory Audit

Analytical laboratories participating in the U.S. EPA's CLP are required to take part in a series of performance and systems audits conducted by the National Enforcement Investigations Center.



C.1.2 Corrective Action

During the course of the Phase II ESA investigations, project field personnel will be responsible for ensuring that field instruments are functioning properly and that work progresses satisfactorily in accordance with the Work Plan. Additionally, field personnel will be responsible for the performance of routine preventive maintenance and QC procedures, thereby facilitating the collection of representative field data.

If an unusual problem is encountered by field personnel, the Project Manager will be notified immediately, at which time the problem will be further investigated and corrective action will begin, if necessary. Similarly, if a problem is identified in the laboratory, an immediate investigation will be undertaken and corrective action will be taken as early as possible.

In cases where corrective actions are required, documentation describing the nature of the problem, an evaluation of the case, if known, and the action taken will be prepared. This report will then be submitted to the Project Manager. Likewise, the laboratory will maintain a file of corrective actions implemented, whether or not the actions performed were pertinent to the analysis of samples from the Phase II ESA.

C.2 Reports to Management

The selected laboratory will provide status reports to the Project Manager, as appropriate. The reports would address the following:

- QA activities and quality of collected data;
- Equipment calibration and preventive maintenance activities;
- Results of data precision and accuracy calculations;
- Evaluation of data completeness and contract compliance;
- Field and/or laboratory QA problems, and recommended and/or implemented corrective actions;
 and
- Results of QA audit findings.



D. DATA VALIDATION AND USABILITY

D.1 Data Review, Verification, and Validation

The overall DQOs for this project will be met by verifying the methods and results to collect, develop, and report the data. The following discussion provides the basis for data review, reduction, validation, and reporting.

D.2 Verification and Validation Methods

D.2.1 Field Data

The field data package will be reviewed by the sampling personnel. To adequately assess the data package, the following items will be reviewed:

- Field data contained in sampling logs for completeness;
- Preparation, identification, and analysis of equipment blanks, field blanks, and trip blanks;
- Field analyses and equipment calibration and general condition; and
- Chain-of-custody forms, i.e., for proper completion, signatures of field personnel, and the laboratory sample custodian.

D.2.2 Laboratory Data

The analytical data package will be verified for completeness, correctness, and conformance of the data. Validation of the data will only be performed if the verification process warrants it. Validation of data, when necessary, will be performed in accordance with the M1 and M2 level of data validation found in the U.S. EPA Region III Innovative Approaches to Data Review Guidance Document (June 1995).

The analytical data package validation procedure may include a review of the following:

- Data reduction procedures specified in 40 CFR §136 and SW-846, as they apply to individual analytical methods.
- The data package by the analytical laboratory relative to the reporting requirements specified in the Data Reporting section of this Plan, to ensure completeness in the analytical data package and compliance with U.S. EPA-approved procedures.
- Sampling dates, sample extraction dates, and analysis dates to check that samples were extracted and/or analyzed within proper holding times.
- Analytical methods and suggested detection limits.



- Field and laboratory blanks to evaluate possible contamination sources. The preparation techniques and frequencies, and the analytical results (if appropriate) will be considered. Blanks will be evaluated in accordance with U.S. EPA Functional Guidelines for Validation of Laboratory Data.
- Field duplicates to check the precision of chemical analyses and field sample collection techniques. If available, field duplicates and laboratory duplicates for water matrices will be reviewed.
- Surrogate spikes relative to allowable control limits specified for the method.
- Matrix spike recoveries for organic analyses (considered advisory by the U.S. EPA) for evaluation
 of the presence of matrix interferences that may affect recovery of a particular analyte. Control
 limits will be reported when matrix spike data are reported. When matrix spike duplicates are
 performed and/or reported, the relative percent difference will be calculated and RPD control
 limits reported.
- Matrix spike recoveries for inorganic analyses (considered definitive). If matrix spike recoveries
 are outside control limits, the data will be flagged as a quantitatively suspect or an estimated
 value.

D.2.3 Data Reporting

The analytical laboratory will provide information concerning overall analytical QA that would allow the project manager to evaluate the quality of the laboratory-generated data. The laboratory will follow the specified reporting requirements, as closely as possible, for both routine and special analytical services.

D.3 Reconciliation with User Requirements

Details concerning the evaluation of data precision, accuracy, and completeness are described in the following sections. This information will be used as a guideline in the overall evaluation of field and laboratory data.

D.3.1 Precision

Precision is defined as an estimate of the reproducibility of a method and/or collection procedure, and is estimated by several statistical tests: the standard deviation of the error distribution, the coefficient of variation (CV), and the RPD between replicate (duplicate) samples. Information regarding the precision of chosen methods would be ascertained, as appropriate, by collecting replicate groundwater samples at a frequency of 1 per 20 or fewer samples, and replicate soil samples at a frequency of 1 per 20 or fewer samples. If sufficient replicate data are collected, the arithmetic mean and standard deviation can be evaluated.



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Precision can also be defined by the CV, which expresses the standard deviation as a percentage of the mean. Specific statistical comparison of replicate (duplicate) data from field and laboratory measurements, as a means of evaluating precision of both sample collection procedures and laboratory performance, may be accomplished by first comparing the obtained replicate (duplicate) results with the published U.S. EPA criteria for method precision. If not available for a given method, the RPD may be calculated and compared to the laboratory precision criteria. This calculated precision value may then be compared with the stated precision DQO for the analyte in question to evaluate whether the DQO has been satisfied.

D.3.2 Accuracy

The accuracy of a method is an estimate of the difference between the true value and the evaluated mean value. Certain QA parameters such as laboratory control samples, reagent water spike samples, QC check samples, matrix spikes, and surrogate spike samples all have known concentrations in them prior to analysis. By comparing the percent recovery results to the known true value, it is possible to measure the accuracy of the analysis. In routine practice, the laboratory will collect the data for each of these parameters for a sequence of at least 30 measurements. The results of these 30 measurements will be calculated. Then, based on the desired level of confidence, two or three standard deviation ranges will be established as practical control limits. These control limits must meet the accuracy limits specified in the appropriate U.S. EPA method for each analyte measured. If the evaluated control limits are within range established for the analyte and method by the U.S. EPA, then the evaluated range becomes the practical control limited use by the laboratory until another set of data is developed and new control limits are calculated.

D.3.3 Completeness

Data completeness is defined both as a ratio of total tests completed to the total tests required in the scope of work. The number of analyses actually completed during the Phase II ESA will be compared against those proposed in the Work Plan. An evaluation of laboratory data completeness will be included in laboratory QA status and/or summary reports to project management.



TABLES



Sample Containers, Preservation, Holding Times Table 1

Technical Holding Time	Varied ⁽³	Varied ⁽³⁾	14 days extract; 40 days analyze	14 days extract; 40 days analyze	180 days; (28 days Hg)	14 days	30 days	
Sample Preservation	Cool to 4°C	Cool to 4°C Sodium bisulfate ⁽³⁾	Cool to 4°C	Cool to 4°C	Cool to 4°C	Cool to 4°C	Not Applicable	
Sample Container ⁽²⁾	Varied ⁽³⁾	Varied ⁽³⁾	8 oz. amber wide-mouth glass with Teflon-lined cap.	8 oz. amber wide-mouth glass with Teflon-lined cap.	8 oz. amber wide-mouth glass with Teflon-lined cap.	8 oz. amber wide-mouth glass with Teflon-lined cap.	Summa Canister	
Minimum Sample Volume ⁽¹⁾	5 g³	5 g³	8 oz.	4 oz.	6 oz.	6 oz.	1 liter to 6 liter	
Parameter/Fraction	Volatile Organics (VOCs) – Medium/High Concentration	Volatile Organics (VOCs) – Low Concentration	Acid Extractable Organics Base & Neutral Organics (BNAs)	Pesticides/Aroclors (PCBs)	Total Metals	Cyanide	Volatile Organics (VOCs)	Add information for other parameters to be measured.
Sampling SOP No.								
Matrix	Soil						Soil Gas	

Legend: (1) Triple volume is required for matrix spike/matrix spike duplicate (MS/MSD) analysis.

(2) In the legend of the table include the source of contaminant-free sample containers. All sample bottles must comply with the standards outlined in the following reference: U.S. EPA (Environmental Protection Agency). December 1992. Specifications and Guidance for Contaminant-Free Sample Containers. OSWER Directive #9240.0-05A,

EPA 540/R-93/051. Office of Solid Waste and Emergency Response, Washington, DC. (3) In the legend of the table include in the option that will be used and preservation information for that option. The CLP Statement of Work (OLM04.2a) provides three options for sample containers, preservatives, and storage procedures. Sample containers can be pre-weighed, closed-system, purge-and-trap vials, Encore (or equivalent)

sample containers or 40 ml, 60 ml, or 4 oz. wide-mouth containers. Samples may also be frozen (-12°C). Refer to Exhibit D – Volatiles, Appendix B in OLM04.2a.

Sample Containers, Preservation, Holding Times (Cont.) Table 1

Matrix	Sampling SOP No.	Parameter/Fraction	Minimum Sample Volume ⁽¹⁾	Sample Container ⁽²⁾	Sample Preservation	Technical Holding Time
Aqueous		Volatile Organics (VOCs)	80 ml.	40 ml. VOC vial with Teflon-lined septum.	1:1 HCl to pH<2; Cool to 4°C; 25 mg. Ascorbic Acid ⁽³⁾	14 days
		Acid Extractable Organics Base & Neutral Organics (BNAs)	2 liters	1 liter amber glass with Teflon- lined cap.	Cool to 4°C; 80 mg. Na ₂ S ₂ O ₃ (sodium thiosulfate) ⁽⁴⁾	7 days extract; 40 days analyze
		Pesticides/Aroclors (PCBs)	2 liters	1 liter amber glass with Teflon- lined cap.	Cool to 4°C	7 days extract; 40 days analyze
		Total Metals	1 liter	1 liter HDPE bottle with Teflon- lined cap.	1N HNO ₃ to pH<2; Cool to 4°C	180 days; (28 days Hg)
		Cyanide	1 liter	1 liter HDPE bottle with Teflon- lined cap.	NaOH to pH<2; Cool to 4°C; 25 mg. Ascorbic Acid ⁽³⁾	14 days ⁽⁵⁾
		Add information for other parameters to be measured.				
l agand.						

Legend:
(1) Triple volume is required for matrix spike/matrix spike duplicate (MS/MSD) analysis.

(2) In the legend of the table include the source of contaminant-free sample containers. All sample bottles must comply with the standards outlined in the following reference: U.S. EPA (Environmental Protection Agency). December 1992. Specifications and Guidance for Contaminant-Free Sample Containers. OSWER Directive #9240.0-05A, EPA 540/R-93/051. Office of Solid Waste and Emergency Response, Washington, DC.

 $^{(3)}$ Ascorbic acid should only be used in the presence of residual chlorine. $^{(4)}$ Sodium thiosulfate (Na₂S₂O₃) should only be used in the presence of residual chlorine.

(5) Maximum holding time is 24 hours when sulfide is present.

Table 2 Quality Control Requirements

Parameter	Field Quality Control Check	Frequency	Corrective Action
Soil Samples	Field Replicate	1 per 20 soil samples.	Review laboratory data to identify problem. If none, evaluate if proper
			sample collection procedures were followed.
	Equipment Blank	1 per 20 soil	Review laboratory data to identify problem. If none, evaluate if proper
		samples.	sample collection procedures were followed.
Groundwater Samples	Field Replicate	1 per 20 water	Review laboratory data to identify problem. If none, evaluate if proper
		samples.	sample collection procedures were followed.
	Equipment Blank	1 per 20 water	Review laboratory data to identify problem. If none, evaluate if proper
		samples.	sample collection procedures were followed.
Soil Gas Samples	Field Replicate	1 per 20 soil gas	Review laboratory data to identify problem. If none, evaluate if proper
		samples.	shipping and handling procedures were followed.
	Field/Trip Blank	1 per sampling event.	Review laboratory data to identify problem. If none, evaluate if proper
			shipping and handling procedures were followed.
Shipping and Handling	Trip Blank	1 per cooler of	Review laboratory data to identify problem. If none, evaluate if proper
•		samples containing	shipping and handling procedures were followed.
		VOC samples to be	
		shipped to laboratory.	

Table 3 Preventative Maintenance Field Equipment

Instrument	Activity	Frequency
pH Meter	Check battery calibration fluid shelf life.	Monthly
Specific Conductance	Check battery calibration fluid shelf life.	Monthly
Turbidity	Check battery.	Monthly
Water Level Meter	Check battery, integrity of tape.	Daily
PID	Check battery, lamps, flow tube, and	Per Use
	calibration gas shelf life.	
Soil Scales (hand held)	Check battery and perform internal calibration. Daily	Daily
Peristaltic Pumps	Check electrical cords and tighten nuts/bolts.	Per Use
Submersible Pump (low flow)	Check electrical cords and tighten nuts/bolts.	Per Use

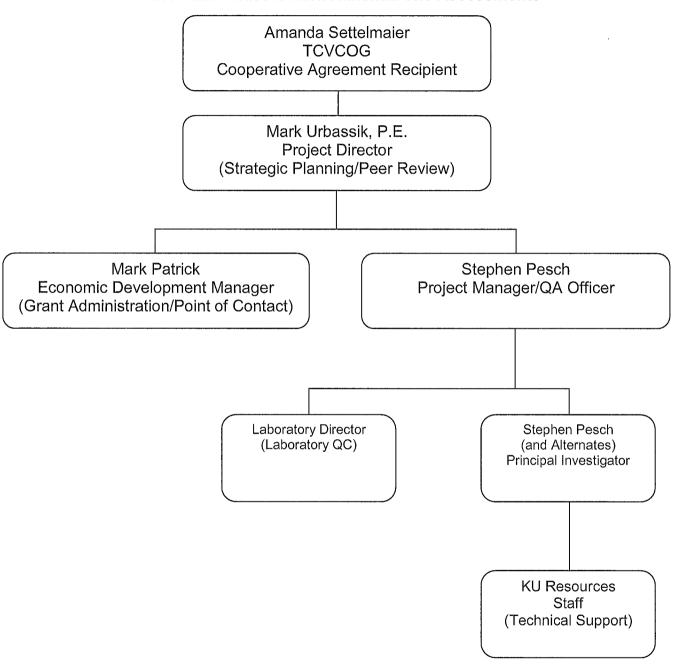
Table 4 Calibration and Corrective Action – Field Equipment

Parameter	Field Quality Control Check	Frequency	Acceptance Criteria	Corrective Action
pH (pH Meter)	Calibrate using buffer solutions that bracket expected pH range (4.0 and 7.0). Duplicate Readings 1 in 10.	Daily	±0.1 pH units	Recalibrate. If unable to calibrate, replace electrode.
Specific Conductance (conductivity meter)	Calibrate using standard solutions that bracket expected specific conductance range of samples. Duplicate Readings 1 in 10.	Daily	±010 µmhos/cm (0-800 µmhos/cm) ±50 µmhos/cm (800-1,000 µmhos/cm)	Recalibrate.
Turbidity (turbidity meter)	Calibrate using a standard within the expected range of sample turbidities. Duplicate Readings 1 in 10.	Daily	± 5 NTUs (for 30 minutes)	Recalibrate.
Temperature (digital thermometer)	Calibrate by bracketing expected range of sample temperatures. Duplicate Readings 1 in 10.	Monthly	±1° C	Examine the probe for cleanliness. Replace, if necessary.
Static water level and total depth of well (water level indicator)	Sounder will be calibrated by measuring a known distance.	Before use in the field.	±0.01 foot	Recalibrate. If unable to meet specifications, unit will be repaired or replaced.
Depth to free-floating product and interface with static water level (interface probe)	Probe will be calibrated by measuring a known distance.	Before use in the field.	±0.01 foot	Recalibrate. If unable to meet specifications, unit will be repaired or replaced.
Organic Vapors (photoionization detector; PID)	Calibrate with isobutylene.	Prior to field activities.	±1% of standard	Recalibrate.
Organic Vapors (organic vapor analyzer; OVA)	Calibrate with methane.	Prior to field activities.	±1% of standard	Recalibrate.

FIGURE



Figure A-1
Project Organization Chart
Turtle Creek Valley Council of Governments
Phase I and Phase II Environmental Site Assessments





ATTACHMENT



ATTACHMENT A STANDARD OPERATING PROCEDURES FOR FIELD INVESTIGATIONS



MONITORING WELL AND PIEZOMETER INSTALLATION

1.0 PURPOSE

This Standard Operating Procedure (SOP) will be used in preparing for and executing groundwater monitoring well installation. This SOP is based on United States Environmental Protection Agency and other guidelines to provide general procedures for monitoring well and piezometer installation. Any exceptions are to be documented in the Site Quality Assurance Project Plan (QAPP) and/or the Sampling and Analysis Plan (SAP).

The construction of monitoring wells allows access to the groundwater so that a representative sample of water can be withdrawn and analyzed. During installation, other subsurface features may be investigated. Monitoring wells are also used to evaluate topics within various disciplines including geology, hydrogeology, and chemistry.

An observation well is constructed as a non-pumping well to observe the elevation of the water table or the potentiometric surface. It is generally of larger diameter than a piezometer and typically is screened or slotted throughout the entire thickness of the aquifer.

A piezometer is generally of small diameter and is used to measure the elevation of the water table or potentiometric surface. A piezometer usually has a short well screen through which water can enter.

A well point or "drive point" is usually installed at a shallow depth within unconsolidated material containing particles less than cobble size. These wells have no filter pack or seal and are usually intended as temporary fixtures to obtain groundwater samples and/or water table levels in a quick and cost-effective manner.

2.0 DRILLING METHODS

The following criteria are used to select an appropriate drilling method (listed in order of importance):

- Hydrogeologic information:
 - Type of formation material,
 - Degree of saturation,
 - Anticipated depth of well/piezometer completion, and
 - Length of desired screen across or below zone of saturation;
- Types of contaminants expected;
- Location of drilling site (i.e., accessibility);
- Design of well/piezometer desired; and
- Availability of drilling equipment.

The various drilling methods are briefly described in the following sections.

2.1 Hollow-Stem Auger

Hollow-stem augering is the most common drilling method for completing boreholes to be used for monitoring wells in unconsolidated materials. No drilling fluids are used and disturbance to the geologic materials penetrated is minimal. Augers cannot be used when consolidated rock must be penetrated. Depths are usually limited to less than 150 feet.

In formations or material where the borehole will not remain open, the monitoring well can be constructed inside the hollow-stem augers prior to removal of the augers from the hole. Generally, the maximum inside diameter of standard augers is approximately 4 inches. However, installation using hollow-stem auger methodology can range to a maximum inside diameter of approximately 10 inches. Hollow-stem augering when used in conjunction with split-spoon sampling techniques enables the driller to collect continuous in-situ geologic samples without removal of the auger sections.

2.2 Cable Tool

Although the rate of penetration is slow, this method has many advantages. With cable-tool drilling, good formation samples can be collected and the presence of thin permeable zones can be detected. Drilling is accomplished by dropping a heavy "string" of drill tools into the borehole. A drill bit attached to the bottom end of the string crushes the material at the bottom of the hole. Water is added to the borehole to create a slurry consisting of drill cuttings and water which is removed periodically using a bailer or pump. As drilling progresses, a casing is usually driven to provide temporary formation support within which the monitoring well can be constructed. This drilling method is becoming less common in the environmental industry, primarily due to the slow drilling rate and the small number of cable-tool rigs available.

2.3 Air Rotary

In air-rotary drilling, a rotating bit is advanced into the borehole under applied pressure to break up the formation and compressed air is forced down the drill stem and back up the borehole to remove the cuttings. This technique is particularly well suited to drilling in consolidated rock formations. If the monitoring is intended for organic compounds, the air must be filtered to ensure that oil from the air compressor is not introduced to the borehole. This technique should be avoided in highly contaminated environments because the air and cuttings blown out of the hole are difficult to control and can pose a hazard to field personnel. Where volatile compounds are of interest, air rotary can volatilize those compounds and cause water samples withdrawn from the hole to be unrepresentative of in-situ conditions. Water can be injected in combination with air in situations where cuttings cannot be adequately removed from the borehole by air alone. Water used for this purpose should be free from contaminants and come from a source such as a public water supply. Any water added to a borehole should be flushed out with air following the completion of the borehole. The use of foam additives to aid in the removal of cuttings from the borehole creates the possibility of organic contamination in the monitoring well and should be avoided.

2.4 Air Rotary with Percussion Hammer

The addition of a percussion hammer increases the effectiveness of air-rotary drilling techniques in unconsolidated, caving, or highly creviced formations. This technique uses a hammer bit to break up the formation instead of a rotating bit. Addition of the percussion hammer gives air rotary the ability to drive casing while advancing the boring, cutting the loss of air circulation in fractured rock and maintaining an open hole in soft formations. The capability of constructing monitoring well inside the casing adds to the advantages of air percussion.

2.5 Reverse-Circulation Rotary Drilling

Reverse-circulation rotary drilling is the opposite of air-rotary drilling in that water is used as a drilling fluid and is circulated down the borehole and up through the inside of the drill stem to remove cuttings. Large quantities of water and equipment are required for this drilling method. If permeable formations are encountered, significant quantities of water can move into the formation to be monitored, altering the chemical character of the water. The quantities of water and larger equipment along with the possibilities of altering the quality of formation water limit the use of this technique for monitoring well construction.

2.6 Dual-Wall Reverse-Circulation Rotary

Reverse-circulation rotary drilling using a dual-wall drill pipe is similar to the previous method except that either air or water or a combination of both can be used to remove cuttings from the borehole. The drilling fluid is contained between the two walls of the dual pipe and contacts the borehole only near the bit. This technique has numerous advantages over standard reverse-circulation rotary drilling. Like air rotary, this technique can also be used with a percussion bit.

2.7 Hydraulic Rotary (Water or Mud Rotary)

Hydraulic-rotary drilling techniques present some disadvantages for monitoring well construction. With hydraulic rotary, either water or a drilling mud (usually bentonite) is circulated down the drill stem and up the borehole to remove cuttings created by the rotating bit. A large amount of water is required to remove cuttings when using water-rotary techniques. This can create some of the same problems as those explained in Section 2.5. In mud-rotary drilling, the mud creates a wall on the side of the borehole which is highly effective in eliminating borehole collapse in unconsolidated materials but must be removed from the well screen area by development procedures (Section 7.0). With small-diameter wells, complete removal of the drilling mud is not always achieved. The ion exchange potential of most drilling muds is high and may effectively reduce the concentration of trace metals in water entering the well. In addition, the use of biodegradable organic drilling muds can introduce organic components into water entering the well.

2.8 Rotary Coring

Rotary coring is similar to the air-rotary method of drilling in that air or water or a combination of air and water is injected through the drill pipe to aid in temperature control of the drilling bit and removal of fine drill cuttings created during coring. The basic difference between this technique and other rotary methods is that instead of the bit breaking up the formation for the entire diameter of the bit, a diamond-impregnated core bit is used that cuts the formation. As drilling proceeds, the rock core is forced up inside an inner barrel of the drill pipe which is retrieved to the surface at specific intervals. This technique

is slower and more expensive than other rotary methods but provides a relatively undisturbed cylindrical sample of the consolidated material which enables very accurate geologic logging and sample collection.

2.9 Direct-Push

Direct-push soil sampling equipment (i.e., Geoprobe® or alternatives) can be used to install small-diameter monitoring wells. These wells can be constructed in a manner similar to hollow-stem auger well construction; alternatively, pre-constructed well screens/filter pack are available for installation. A separate SOP for direct-push well installation prepared by Geoprobe®, is included if applicable to the project.

3.0 MONITORING WELL, OBSERVATION WELL, PIEZOMETER, AND DRIVE POINT DESIGN

The materials and techniques used for installing a well, piezometer, or drive point must not alter the quality of the water being sampled. Several elements need to be considered in their design. They are described in the following sections and apply to monitoring and observation wells, piezometers, and drive points (collectively referred to as wells).

3.1 Location and Number

Locating wells horizontally and vertically to ensure that the targeted groundwater flow regime is being monitored is one of the most important elements of well design. The number of wells and their location are principally determined by the stated goal of the monitoring program. In most monitoring situations, the goal is to determine if some nearby surface or near-surface activity has affected groundwater quality or to provide early warning of groundwater degradation. Several wells are generally installed in a downgradient direction of the site of the activity in the first continuous water-bearing unit. At least one well should be installed upgradient of the site in order to obtain background groundwater information for use in determining the impact of site activities. Consideration should be given to seasonal and artificial fluctuations in water table elevation. Artificial fluctuations include pumpage, which will cause water levels to fall and flow toward the pumping well and lagoon or landfill operation, which can cause a rise or "mound" in the groundwater elevation. Boreholes and/or wells can be constructed for the collection and analysis of geologic samples, groundwater levels, and water quality samples to guide the placement of additional wells. Accurate water level information must be obtained.

Factors that govern where and how many wells should be constructed include the following:

- Site geology and hydrogeology;
- Source characteristics;
- Contaminant characteristics;
- Size of the area under investigation; and
- Accessibility.

3.2 Diameter

In the past, the diameter of a monitoring well was based primarily on the size of the device (bailer, pump, etc.) being used to withdraw the water samples. This practice worked well in very permeable formations. However, monitoring wells are sometimes completed in very marginal water-producing zones. With the

advent of commercially available small-diameter pumps capable of lifting water over 100 feet, 2-inch inside-diameter monitoring wells have become the standard in monitoring well technology. Large-diameter wells can be useful in situations where monitoring may be followed by pumping tests. In some instances, the "monitoring" well may become a "recovery" well to remove contaminated water for treatment. Larger-diameter wells may be considered when monitoring requires depths of hundreds of feet. Piezometers, observation wells, and well points are typically constructed with diameters of 2 inches of less.

3.3 Casing and Screen Material

The type of materials used for well construction can have an effect on the quality of the groundwater sample collected from a well. The materials selected for well construction should retain their structural integrity for the duration of the monitoring program under actual subsurface conditions. They should neither absorb nor leach chemical constituents which would bias the groundwater samples. The following is a list of materials that could be used for casing and screen construction:

- Galvanized steel, carbon steel, and low-carbon steel;
- Polyvinylchloride (PVC); or
- Stainless steel.

The following sections present a summary of the advantages and disadvantages of each material relative to groundwater chemistry.

3.3.1 Galvanized Steel, Carbon and Low-Carbon Steel

Galvanized steel can impart iron, manganese, zinc, and cadmium to groundwater within the well. Carbon steel and low-carbon steel may impart iron and manganese to a sample. For these reasons, these materials are not commonly used for monitoring well construction and should be avoided.

3.3.2 PVC

PVC has very good chemical resistance except to low molecular weight ketones, aldehydes, and chlorinated solvents. As the organic content of a solution increases, direct attack on the polymer matrix or chemical absorption, adsorption, or leaching may occur. PVC pipe has been shown to release and adsorb trace amounts of various organic constituents to water after prolonged exposure. Threaded joints are the only permitted means for connecting sections. PVC solvent cements used to attach nonthreaded sections of PVC pipe have been shown to release significant quantities of organic compounds and should never be used.

3.3.3 Stainless Steel

Stainless steel is the most chemically resistant of the ferrous materials. Stainless steel may, however, be subject to pitting and corrosion especially over long-term exposures under acidic conditions. Casing and well screen constructed of stainless steel is commonly used in situations where sampling for organic contamination is of prime importance.

3.3.4 Cleaning

Care must be given to the preparation of the casing and well screen materials prior to installation. At a minimum, materials should be inspected when received. Generally, materials purchased from the factory

are decontaminated and packaged in sealed containers. Steam cleaning or high-pressure hot water cleaners will remove cutting oils and lubricants left on metal casings and screens after manufacture. To ensure that these and other sampling materials are protected from contamination prior to placement, materials should be covered with plastic sheeting or aluminum foil and kept off the ground.

3.3.5 Screen Slot Size/Filter Pack

Commercially manufactured well screens are preferred for monitoring well design given that the proper screen slot size is chosen. In formations where fine sand, silt, and clay predominate, it may be necessary to determine slot size through sieve analysis of grain size distribution. Field methods of screen slot size manufacturing such as sawed or torch-cut slots should never be used.

For natural-packed wells (no filter pack) where relatively homogeneous and coarse materials predominate, a slot size should be selected that will restrict from 40 to 50 percent of the screened material. In cases where adequate well development procedures may be difficult to complete, a smaller slot screen should be selected. Silty and clayey zones may require an artificially emplaced, graded pack to keep the fine particles while keeping the pore space open. In an artificial pack, a graded filter-pack size that is from three to five times the 50 percent size of the formation and a screen size that will retain at least 90 percent of the pack material should be used. The filter pack should be composed of clean uniform silica sand. Centralizers are used in deep boreholes (greater than 250 feet) to ensure that the well will maintain a vertical orientation at completion.

Placement of the filter pack should be completed carefully to avoid bridging in the borehole and to allow uniform settling around the screen. If the depth of water standing in the annulus is not great, the sand can be poured from the surface. If the water is deep (greater than 20 feet), the well is deep (greater than 50 feet), or the borehole is not smooth, bridging of the material may occur and the filter pack material should be installed using a tremie method. Calculations should be made to determine what volume of sand will be required to fill the annulus to the desired depth (usually about 1 to 2 feet above the top of the screen for coarse sand) plus 1 to 2 feet of fine sand above that for a finer buffer pack between the main pack and the seal material. Field measurements should be taken to confirm the pack has reached this level before sealing procedures start.

A tremie pipe is a hollow, thin-walled, rigid tube or pipe which is commonly fabricated by connecting individual lengths of threaded flush-joint pipe. The tremie pipe should have a sufficient diameter to allow passage of the filter pack through the pipe. The inside diameter of a tremie pipe used for filter pack placement is about 1-1/2 inches to greater to minimize bridging problems inside the tremie.

Placement of the filter pack begins by lowering a measuring rod or weighted measuring tape to the bottom of the borehole. A measured portion of the precalculated volume of filter pack is slowly poured or washed with water down the tremie and the tremie is slowly raised as the filter pack discharges from the bottom of the pipe, filing the annular space between the well intake and borehole wall.

3.4 Screen Length and Depth of Placement

The length of screen chosen and the depth at which it is placed are primarily dependent on the behavior of the contaminant as it moves through the unsaturated and saturated zones and/or the goal of the

monitoring program. Screen the entire thickness of the water-bearing formation when monitoring a potable water supply aquifer.

When sampling specific, multiple, depth intervals at one location, a cluster of wells is common. This technique is often necessary when the saturated zone is too thick to adequately monitor with one screened section (which would cause dilution of any contaminants) or when a determination of vertical gradients is desired. Contaminants tend to stratify within the saturated zone. Collection of a sample over a thick zone will give little information on the depth and concentration that a contaminant may have reached.

Screen lengths of 5 to 10 feet are typically installed in detailed plume geometry investigations. Thick aquifers may require that several wells be completed at different depth intervals. In such situations (and depending on the magnitude of the aquifer saturated thickness), screen lengths of no more than 10 feet should be used. Well screen lengths greater than 10 feet may be appropriate under certain site- and/or project-specific conditions. Clustered monitoring wells are constructed in separate holes placed closely together.

In other situations, only the first water-bearing zone beneath the ground surface encountered will require monitoring (for example, in most Phase II site assessments or when monitoring near a potential contaminant source in a relatively impermeable glacial till). Here, the "aquifer" or zone of interest may be only 6 inches to a few feet thick. Screen length should be limited to 5 feet or less in these cases to minimize siltation problems from surrounding fine-grained materials and possible dilution effects from water contributed by uncontaminated zones.

Because of the chemical reactions which occur when groundwater contacts the atmosphere particularly for volatile compounds, aeration of the screened section should be avoided. Well depth should assure that the screened section is usually fully submerged except when monitoring for free-product conditions or lighter-than-water contaminants. Wells constructed to monitor for floating contaminants should contain screens which extended above the zone of saturation so that lighter-density substances can enter the well. The screen length and position must accommodate the magnitude and depth of variations in water table elevation. It should be noted that the thickness of floating product in the well does not necessarily indicate the thickness of the product in the aguifer.

3.5 Sealing Materials and Procedures

It is critical that the screened portion of each monitoring well access groundwater from a specific depth interval only. Rainwater can infiltrate a well backfilled with drill cuttings, potentially diluting or contaminating samples. Also, vertical seepage of leachate along the well casing will also produce unrepresentative samples. Strictly avoid the creation of a conduit in the annulus of the monitoring well that could contribute to or hasten the spread of contamination between aquifers.

Monitoring wells are sealed with 2 to 4 feet of pure hydrated bentonite pellets above a fine-grained silica sand filter (buffer). A cement/bentonite grout seal is placed to the ground surface above the pellet seal. Proper sealing of a well insolates the screened interval, prevents the downward migration of contaminants in the borehole, and prevents mixing of waters in zones above the monitoring interval. No

sand or gravel is used in downhole cement. Sand is only used in cement placed near or at the surface to guard against frost heave and to stabilize the well's outer protective casing.

The use of pure bentonite is considered a much better seal than cement. However, recent investigations on the use of clay liners for hazardous waste disposal have shown that some organic compounds migrate through bentonite with little or no attenuation. Therefore, cement may offer some benefits over bentonite.

When bentonite must be placed below the water table (or where water has risen in the borehole) and the possibility of bridging or hydration of pelletized bentonite before reaching the proper depth exists, it is recommended that a thick bentonite slurry be piped down the annulus through a tremie pipe to fill the hole from the bottom upward. This method of placement should also be used for the cement/bentonite grout seal above the bentonite, if the borehole contains water or is greater than 20 feet in depth. The bottom of the tremie pipe should always be fitted with a "T" or "elbow" joint to ensure discharge to the side rather than injecting directly into the filter pack or bentonite seal.

Bentonite clay has appreciable ion exchange capability which may interfere with the chemistry of collected samples when the seal is close to the screen or well intake. Cement grout has been known to seriously affect the pH of sampled water when improperly placed. Therefore, special care should be exercised during placement of a downhole seal. A 1- to 2-foot fine-grained silica sand should extend above the top of the coarser filter pack sand to ensure that the sealing materials do not migrate downward into the filter pack and well screen. If the water content of sealing material is too high, settling or migration of sealing materials into the gravel pack or screened area may occur and the fine materials in the seal may penetrate the pack. Likewise, adequate time must be allowed for hydration (several hours) when using pelletized bentonite for the well seal immediately above the filter pack before the addition of grout to eliminate the grout from entering the filter zone.

While a neat cement grout is often recommended especially for surface sealing, shrinkage and cracking of the cement upon curing and weathering can create an improper seal. Shrink-resistant cement (such as Type K Expansive Cement) and mixtures of small amounts of bentonite with neat cement have been used successfully to help prevent cracking. Typically, a mixture of Type IA cement grout containing a 5 percent mix of powdered bentonite is used for the borehole seal above the pure bentonite seal. A concrete mix such as Sakcrete or cement grout mixed with sand is used as the surface seal in order to support the well's protective casing and to guard against frost heaving.

3.6 Grout Mixtures

When installing a monitoring well, observation well, or piezometer, the grout mixture should be prepared to inhibit shrinkage during curing while maintaining strength. Portland Type IA cement should be used and mixed dry with bentonite powder. From 2 to 5 pounds of bentonite powder should be combined with each bag (94 pounds) of cement used. Once the cement and bentonite are thoroughly mixed, potable water is added. Approximately 7 gallons of potable water should be used for each bag of cement added. The resulting mixture will produce approximately 11 gallons of grout slurry.

To determine how much grout will be required, first measure the distance from ground surface to the bentonite seal or, if installing surface casing, to the bottom of the borehole. The grout volume required can then be calculated using the following equation:

$$V - \pi \left(r_2^2 - r_1^2\right) d \tag{1}$$

where:

V = Volumne (length³),

 $\pi = 3.14159$.

 r_2 = radius of the borehole annulus (length),

 r_1 = outside radius of the surface casing or riser pipe (length), and

d = depth to be grouted (length).

Once the volume is calculated, convert to gallons (0.134 cubic foot per gallon) and divide by 11. This will give you the approximate number of bags of cement to be used. Note that this is an approximation; always round up since grout loss to the formation typically occurs. In situations where grout loss to the formation occurs dramatically such that the calculated volume of grout required is greatly exceeded, the grout should be allowed to cure and the depth at which the loss is occurring determined. The grout will settle and subsequently cure immediately below the level at which loss is occurring. A few feet of bentonite pellets or "hole plug" installed through the zone prior to the continuation of grouting will usually block off the zone. However, boring logs for the hole should be examined to determine the length of the highly permeable zone of fracture zone.

When grouting deep wells, the cement/bentonite grout should be installed in stages or "lifts" allowing each lift to cure before adding more grout. This method decreases the chances of well casing failure due to pressure from the grout column. Seventy-five feet is the maximum lift when the well casing is constructed of Schedule 40 PVC. Schedule 80 PVC and stainless steel have slightly higher collapse strengths.

4.0 SECURITY

For most monitoring well installations, precautions must be taken to protect the exposed portions of the well from damage. Where the most likely problem is one of vehicular contact, a monitoring well may be:

- flagged;
- painted;
- protected by guard posts;
- protected with steel casing and locking caps;
- flush mounted with locking caps; or
- any combination of the above.

To install a monitoring well with protective casing, make sure the well casing extends 2 to 2-1/2 feet above ground surface to be visible above grass, weeds, or small shrubs. If that is not practical, use a flag that extends above the well casing. This is also helpful when leaves or snow may bury to obscure the well.

The portion of the well that protrudes from the ground should be protected. Well protectors include the use of steel casing of larger diameter than the well placed around the well and extending a minimum of 2-1/2 feet below ground. The protectors are usually seated in concrete to a depth below the frost line. A minimum of 10 feet of casing is required at landfills within Pennsylvania. Grout is brought to the ground surface within the well annulus. A small-diameter (one-eighth inch) weep hole is drilled about 6 inches above the concrete to act as a drainage point and the protective casing is filled with coarse sand. Following installation of the protective casing, a minimum 2-foot-by-2-foot pad composed of concrete is emplaced around the well and tapered to facilitate surface drainage away from the well. Well integrity should be questioned if surface concrete is cracked or when the protective casing appears obviously bent or loose. Well protectors are commonly equipped with a locking cap which ensures against tampering with the inside of the well.

Paint the protective well casing a bright color (fluorescent orange and yellow are the most visible). This not only makes the well more visible but also protects metal casing material from rusting. Care should be taken that paint does not get inside the well casing or in threaded fittings that may contact sampling equipment.

5.0 SPECIAL INSTALLATION TECHNIQUES

There are a number of geologic factors that could interfere with the planned installation of wells and piezometers. A few of the most common situations that challenge project personnel and the methods to overcome them are described in the following sections.

5.1 Telescoping Well Installation Through Multiple Aquifers

Well installations in multiple-aquifer groundwater systems are commonly established to provide a variety of hydrogeologic and hydrogeochemical information, such as vertical groundwater gradient and vertical extent of contamination. To prevent the borehole from becoming a conduit for vertical groundwater migration, a well is installed by telescoping the surface casing, well screen, and riser pipe. To install a well through a multiple aquifer, the approximate depth of the target horizon and all overlying water-bearing zones should be identified, if possible, by the project team prior to drilling. A boring (typically greater than 8 inches in diameter is advanced into the aquitard overlying the target horizon. Large-diameter surface casing composed of either PVC or steel is then installed in the borehole and grouted to ground surface with a cement/bentonite grout. Typically, 8-inch inside-diameter casing is used when installing a 4-inch inside-diameter well, and 6-inch inside-diameter casing is used when installing a 2-inch inside-diameter piezometer or observation well.

The cement/bentonite grout can be installed in various ways. One method is to set the surface casing on the bottom of the boring and inject the grout through a tremie pipe placed near the base of the borehole between the casing and the annulus. The grout should be allowed sufficient time to cure (no less than 12 hours and preferable 24 hours) so that continued drilling will not affect the seal that has been created. After the grout has cured, the borehole is advanced to the targeted depth with a drill bit sized to fit inside the surface casing. The well is then completed according to procedures previously described. Importantly, the surface casing should be vertical when installed. If the casing is angled, the drill bit and rods will be unable to advance to the target horizon. Verticality can be accomplished by either installing

centralizers on the outside of the surface casing or by lifting the casing with the drill rig winch slightly off the bottom of a swab or plug set inside the bottom of surface casing prior to the grouting.

A second method for grouting installation is to have the drill rig suspend the casing about 1 foot above the bottom of the borehole. The cement/bentonite grout can be installed through the center of the casing by pouring or by using a tremie pipe, if water is present in the borehole. The grout is then forced out the bottom of the surface casing into the annular space between the surface casing and the borehole using a swab. It is noted that a sufficient volume of gout is placed to allow circulation to ground surface after swabbing. Once the grout has circulated to ground surface, the swab is left in place until the grout has cured. After curing, the borehole can be advanced to the target horizon. However, this method requires that prior to advancing through the aquitard, all remnants of grout be removed from the inside of the surface casing and the bottom of the borehole to eliminate the possibility of contamination the lower aquifer with grout. This is achieved by drilling out any large pieces of grout and then flushing the casing and the bottom of the borehole with injected air and fresh water to remove any remnant contamination. Grout removal is verified by monitoring pH of the return water. Flushing is complete when the pH of the return water is plus or minus 10 percent of that of the water before injecting. Following completion of flushing, all water remaining inside the surface casing must be removed prior to the continuation of drilling.

As a timesaving measure and in situations where only one water-bearing zone is to be cased off from the borehole, a 3- to 5-foot cement/bentonite grout seal or "plug" can be installed at the bottom of the borehole and drilling resumed following curing of the grout. As in the previous method, all remaining grout must be flushed from the casing prior to the continuation of drilling. The annulus between the top of the borehole and the top of the casing should be sealed by packing with plastic sheeting to eliminate filling with return water and/or cuttings during flushing and drilling. The annulus can be completely grouted by the tremie method in conjunction with grouting during well completion.

For areas where more than two aquifers are concerned and known groundwater degradation exists in one or more of the upper water-bearing zones, it may be necessary to case (telescope) through each zone individually. In this situation, the procedures described above are used; however, the diameters of the uppermost borings and surface casings will increase. The specific number of telescoped zones and the necessary diameters of the borings and surface casings should be determined by the project team.

5.2 Installation of Wells Underlying Mine Voids

When wells are installed in horizons that underlie mine voids, specific procedures are followed to ensure that no water within the mine void percolates into underlying water-bearing zones. Likewise, the procedures ensure that the boring above the void is sealed such that it does not act as a conduit for flow into the void. Once the mine void is encountered (typically verified by a "tool drop" and/or loss of return following a highly fractured zone), the total thickness of the void should be noted. The borehole should be advanced 2 to 6 feet into the floor of the mine. A grout basket sized to fit between the outside of the surface casing and the borehole annulus should be attached to the surface casing and the borehole annulus at a point above the top of the void and above any highly fractured mine roof areas. The surface casing is then lowered into the borehole and suspended slightly above the top of the void and above any highly fractured mine roof areas. The surface casing is then lowered into the borehole and suspended slightly above the bottom of the boring. A cement/bentonite grout is pumped down the inside of the

casing through a tremie pipe. The cement/bentonite grout is added until the level is at the bottom of the mine void. The surface casing is then lowered to the bottom of the borehole. Bentonite pellets are dropped into the grout basket between the outside of the surface casing and the borehole wall. At least 4 feet of bentonite should be installed in order to ensure a proper seal above the mine. The bentonite is hydrated with potable water. After the bentonite has been hydrated, cement/bentonite grout is added to the annulus above the grout basket through a tremie pipe with pumping continuing until the grout circulates to the ground surface. As explained above, the inside of the casing and the bottom of the borehole must be thoroughly flushed of all grout remnants before advancing the boring to horizons below the mine void.

5.3 Installation of Wells Within Mine Voids

Mine voids that contain groundwater may act as preferential pathways for contaminant migration and, therefore, certain situations call for the monitoring of mine voids themselves. The installation of a monitoring well inside a mine void is similar to that used for casing through a mine void except the bottom of the larger-diameter casing is capped instead of grouted in place and the bottom section of this casing is slotted (approximately one-eighth-inch-wide slots) for a length equal to the void space. This slotted section of casing is used to contain the filter pack for the well installed inside the casing while allowing water to pass into the filter pack and the well. Commercially manufactured dual-wall "pre-packed" well screens are also available which can be used in the same way. Grout basket installation and grouting above the void are accomplished using the same procedures outlined in Section 5.2.

5.4 Drilling in Steeply Dipping Bedrock

When drilling in areas where bedrock is steeply dipping, the borehole must remain vertical. Sometimes the drill bit and rods will stray from vertical and follow the path of least resistance. These paths may include fractures, bedding planes, or lithologic contacts where the bit is advanced from a softer unit into a harder unit. To prevent the bit from straying from vertical, a drill rod equipped with a stabilizer should be used as the lead drill rod (attached to the bit). The stabilizer utilizes flanges which are attached to the length of the drill rod. These flanges prevent the rod from flexing under pressure, thereby maintaining a vertical borehole.

5.5 Installation of Shallow Wells

When a well is required to monitor a water table or perched zone that occurs at very shallow depths, the length of the well screen must be adapted to meet the depth restrictions. The protective surface casing should be installed to a depth of at least 2-1/2 feet below ground surface. All volumes of construction materials (coarse sand, fine sand, bentonite) can be decreased (i.e., extend sand pack only slightly above the top of the screen, etc.)

5.6 Borehole Collapse

When drilling in loosely packed materials (e.g., alluvium, glacial till, or mine spoil, etc.) using water or airrotary drilling techniques, the borehole may collapse. The type of drilling equipment available will dictate what procedures may be followed in this event. Usually an oversized borehole can be advanced to the zone of collapse and casing can be installed. Drilling then continues by using a bit size that can fit inside the casing. The bit is advanced a few feet below the casing then the casing is advanced using a weighted hammer or air hammer. The inside of the casing must be cleaned out with air or water to

remove cuttings after each advance. Some air-rotary drill rigs are equipped with ODEX drilling systems. ODEX drilling systems enable the drillers to drive surface casing directly behind the advancing drill bit. This is the preferred method; if geologic conditions indicate that borehole collapse may occur, appropriate arrangement should be made prior to commencing drilling operations.

5.7 Flowing Sands

Flowing sands, sometimes referred to as running sands, are usually encountered in alluvial aquifers near large bodies of water, but can also occur in floodplains of small streams. A flowing sand condition occurs when water within an alluvial aquifer is under pressure. As the borehole is advanced, groundwater and unconsolidated alluvium will rush into the void space. This effect is most noticeable when drilling using hollow-stem augers because the airspace within the augers offers little resistance to the inflow of water and sand. Tidal influences may also affect the magnitude of flowing sands at any given time during a work day.

Filling the augers with potable water during drilling to create resistance to the inflow of groundwater and alluvium will sometimes counter-balance the formation pressure and keep the augers clear. If water alone is not sufficient, powdered bentonite may also be added to the water within the auger to create an increased density slurry and prohibit migration of alluvium into the augers. However, use of a slurry may increase the difficulty of obtaining representative subsurface samples and may change the hydraulic properties of the aquifer immediately surrounding the boring. The slurry or water must be maintained within the augers at a level sufficient to mitigate alluvial movement during the remainder of drilling after flowing sands are encountered. Minimal use of these fluids is recommended because any liquids introduced into the formation during drilling must be removed during well development. Remember that a thinner bentonite slurry is easier to remove from the formation during well development, thereby decreasing its impact on the hydraulic properties of the surrounding aquifer. Any alluvium remaining within the augers may be removed using water or air-rotary techniques within the hollow-stem before well installation.

In situations where the termination depth is known prior to drilling, soil sampling is not required, the augers may be fitted with an expendable knock-out plug (typically wood). The borehole is drilled to the termination depth and the drilling rods or monitoring well screen/casing is used to unseat the plug prior to removing the augers.

6.0 TYPICAL MONITORING WELL INSTALLATION THROUGH HOLLOW-STEM AUGERS

The drilling procedures used when constructing monitoring wells with hollow-stem augers are not standardized or thoroughly documented in published literature. Lack of standardization is partially due to variable hydrogeologic conditions which significantly influence hollow-stem auger drilling techniques and monitoring well construction practices. Many of these construction practices evolved in response to site-specific drilling problems which are unique to the hollow-stem auger technique. The following discussion should be considered a "typical" installation procedure.

Once the borehole has been advanced to the desired depth for installation of the monitoring well, the pilot assembly and center rod (if used) are removed and the depth of the borehole is measured. A measuring

rod or weighted measuring tape is lowered through the hollow axis of the auger column. This depth measurement is compared to the total length of the auger column in the borehole to determine whether loose sediments have risen or bridged inside the hollow-stem augers. Provided that the auger is clear of sediment, a string of well casing with attached screen is lowered inside the auger column. Threaded flush-joint casing and well screen are used to provide a uniform outside and inside diameter.

The inner diameter of the auger should be at least 2 inches greater than the outer diameter of the well casing for effective placement of the filter pack and annular sealant.

6.1 Installation of Filter Pack

After the well casing and screen are inserted through the hollow axis of the auger column, the next phase is the installation of a filter pack. The filter pack is placed in the annular space between the well screen and borehole wall.

The volume of filter pack required to fill the annular space between the well intake and borehole wall should be predetermined prior to placement. To determine the volume of filter pack needed, three design criteria should be known. These criteria are: 1) the design length of the filter pack, 2) the diameter of the borehole, and 3) the outside diameter of the well screen and casing. This information is used to calculate both the volume of the borehole and the volume of the well screen and casing over the intended length of the filter pack. Once both volumes are calculated, the volume of the well screen and casing is subtracted from the volume of the borehole to determine the volume of filter pack needed to fill the annular space. The equation given in Section 3.6 can be used to approximate the filter pack volume with the parameter "d" being the length of the filter pack. Once the approximate volume of the filter pack to determine the amount of the material which is needed to fill the annulus for each lineal foot is calculated the auger column is retracted.

The methods which are used to convey the filter pack through the working space in the auger column and to place this material in the annular space depend on 1) the cohesiveness of the formation materials, 2) the height of a standing water column in the working space between the casing and augers, and 3) the grain-size and uniformity coefficient of the filter pack. In cohesive formation materials in which the borehole remains open, the filter pack is placed by axially retracting the auger column in short increments and pouring the filter pack either directly or through tremie pipe down the working space between the casing and auger column. The auger column is initially retracted 1 or 2 feet from the borehole. A measured portion of the precalculated volume of the filter pack is slowly poured down the working space between the well casing and auger column. The filter pack is poured at a point opposite the measuring rod or weighted measuring tape. As the filter pack is being poured, the measuring device is alternately raised and lowered to "feel" or measure the actual placement of the filter pack. If a weighted measuring tape is used as the measuring device, the tape is kept in constant motion to minimize potential binding and loss of the weighted tape as the filter pack is being poured. Continuous measurements of the depth to the top of the filter pack are usually made as the filter pack is slowly poured down to avoid allowing the filter pack to rise up between the well screen/casing and the inside of the hollow-stem auger. If the filter pack is permitted to rise up between the casing and auger, the filter pack may bind between the casing and auger and result in the casing being retracted from the borehole along with the augers. Once the filter pack is placed to the bottom of the auger column, the augers are retracted another 1 to 2 feet and a second measured portion of the filter pack is added. These steps are repeated until the required length of

filter pack is placed. By predetermining the amount of filter pack material needed to fill the annular space for each increment in which the auger column is retracted, the emplacement of the filter pack may be closely monitored. Calculations of the filter pack needed and used should be made and recorded for each increment that the auger column is retracted. Any discrepancies should be explained.

Placement of filter pack material by free fall through the annular space can present the potential for bridging or segregation of the filter pack material. Bridging can result in unfilled voids within the filter pack or in the failure of the filter pack materials to be properly conveyed through the working space between the well casing and auger column. Bridging problems, however, may be minimized by 1) an adequately sized working space between the well casing and auger column, 2) slowly adding the filter pack in small amounts, and 3) carefully raising and lowering the measuring rod or weighted measuring tape while the filter pack is being added.

Potential bridging problems or segregation of graded filter packs may be minimized by using a tremie pipe to place the filter pack. The use of a tremie pipe may be particularly important where the static water level between the well casing and auger column is near surface. At depths greater than 50 feet, a tremie pipe should be used to convey and place the filter pack through hollow-stem augers.

Placement of the filter pack begins by lowering a measuring rod or weighted measuring tape to the bottom of the borehole. The auger column is retracted 1 to 2 feet and the tremie pipe is lowered to the bottom of the borehole through the working space between the well casing and auger column. A measured portion of the precalculated volume of filter pack is slowly poured or washed with water down the tremie. The tremie is slowly raised as the filter pack discharges from the bottom of the pipe, filing the annular space between the well intake and borehole wall. Once the filter pack is placed to the bottom of the auger column, the augers are retracted another 1 to 2 feet and a second measured portion of the filter pack is added through the tremie pipe. This alternating sequence of auger column retraction followed by additional filter pack placement is continued until the required length of filter pack is installed. Careful measurements are taken and recorded for each increment of filter pack material added.

During filter pack placement, whether by free fall or tremie methods, the auger column should be retracted from the borehole. Augers are retracted by hooking a winch line onto the outside of the open top of the auger column. The winch line is then used to retract the augers. The use of a winch line rather than the drive head to pull the auger column from the borehole enables the measuring rod, weighted measuring tape, or tremie pipe to remain in the working space between the well casing and the auger column as the augers are retracted. This technique provides greater continuity between measurements taken during each increment of filter pack placement. Retracting the auger column using the winch line permits the option of adding filter pack material while the auger column is simultaneously withdrawn from the borehole. Bridging problems which can seize the well casing and augers together and cause the casing to pull out of the borehole, may also be more readily detected when the auger column is retracted by using a winch line. The use of a winch line, however, may pull the auger column off center. If the auger column is pulled off center, there may be an increased potential for the casing to become wedged within the augers.

When the formation materials adjacent to the well screen are non-cohesive and the borehole will not remain open as the auger column is retracted, the method for installing the filter pack may require the use

of clean water. Similar to the other methods of filter pack placement, a measuring rod or weighted measuring tape is first lowered to the bottom of the borehole through the working space. Clean water is added to the working space to maintain a positive pressure head in the auger column. As the auger column is slowly retracted, a measured portion of the precalculated volume of filter pack is poured to tremied down the working space. The head of water in the working space forces the borehole to remain open while the filter pack material is placed in the annular space. This procedure of slowly retracting the auger column with a winch line while filter pack material is poured through a positive pressure head of water should continue until the required length of filter pack is installed.

6.2 Installation of Annular Seal

Once the well screen, well casing, and filter pack are installed, the final phase of monitoring well construction is the installation of an annular seal. Bentonite pellets are placed through the hollow-stem augers by free fall through the working space. Prior to placing the bentonite pellets, the approximate volume of bentonite pellets needed to fill the annular space over the intended length of the seal is determined using the method previously described for filter pack material and grout. A measuring rod or weighted measuring tape is lowered to the top of the filter pack through the working space. A depth measurement is taken and recorded. The auger column is then retracted 1 or 2 feet from the borehole and a measured port of the precalculated volume of pellets is very slowly poured down the working space. The pellets will free fall through the working space and fill the annular space immediately above the filter pack. As the pellets are being added, the measuring rod or weighted measuring tape should be removed from the augers to eliminate the bridging of pellets. The depth of the bentonite pellets should be measured periodically throughout this process but never while the pellets are being added or still in suspension. Once the bentonite pellets are placed to the bottom of the auger column, the augers are again retracted 1 or 2 feet and more pellets are added. This procedure continues until the pellets are installed to the required height above the filter pack. The final depth measurement of the pellets is recorded and compared with the calculations for the volume of pellets needed and the actual amount of pellets used.

The free fall of bentonite pellets through the working space provides the opportunity for bridging problems to occur. Bridging problems are likely to occur particularly when the static water level in the working space is near the surface and the well is relatively deep. As bentonite pellets fall through a column of standing water, the bentonite on the outer surface of the pellet begins to hydrate and the pellet surface expands and becomes sticky. Individual pellets may begin sticking to the inside wall of the auger column or to the outer surface of the well casing after having fallen only a few feet through a column of water. Bentonite pellets may also stick together and bridge the working space. As a result, the pellets may not reach the intended depth for proper annular seal placement. The pellets will continue to expand as the bentonite fully hydrates. An expanding bridge of bentonite pellets in the working space may eventually seize the well casing and auger column together, causing the casing to pull out of the borehole as the auger column is retracted.

The potential problems of bentonite pellets bridging the working space may be avoided by using a bentonite slurry instead of pellets. The slurry is pumped under positive pressure through a tremie pipe which is first lowered through the working space. However, tremie placement of a slurry or grout directly on top of the filter pack is not recommended because these slurry mixtures may easily infiltrate into the filter pack. A 1- to 2-foot-thick fine sand layer is placed on top of the filter pack prior to placement of the

slurry or grout. The fine sand layer minimizes the potential for the grout to infiltrate into the filter pack. When bentonite pellets are used, a suitable hydration period, as recommended by the manufacturer, should be allowed prior to the placement of the grout. Failure to allow the bentonite pellets to fully hydrate and seal the annular space above the filter pack may result in the grout infiltrating into the filter pack.

A side-discharge tremie pipe rather than a bottom-discharge tremie pipe should be used to place grout or bentonite slurry above the filter pack. A side-discharge tremie pipe may be fabricated by plugging the bottom end of the pipe and drilling two or three holes in the lower 1-foot section of the tremie pipe or by attaching an elbow or "T" fitting to the bottom of the pipe. The pumped slurry will discharge laterally from the pipe and dissipate any fluid-pumping energy against the borehole wall and well casing. This eliminates discharging the pumped slurry directly downward toward the filter pack and minimizes the potential for sealant to infiltrate the filter pack.

Prior to placing a sealant via the tremie method, the approximately volume of slurry needed to fill the annular space over the intended length of the annular seal is determined. An additional volume of annular sealant should be prepared and readily available for use at the drill site if a discrepancy occurs between the volume of sealant needed and the volume used. The installation of the annular sealant should be completed in one continuous operation.

The procedures for placing the annular sealant with a tremie pipe begin by lowering a measuring rod or weighted measuring tape through the working space. A measurement of the depth to the top of the fine sand layer above the filter pack is taken and recorded. The auger column is retracted 2-1/2 to 5 feet and a side-discharge tremie pipe, with a minimum 1-inch inside diameter, is lowered through the working space. The bottom of the tremie is positioned above the fine sand layer or bentonite pellet seal. A measured portion of the precalculated volume is pumped through the tremie. The sealant discharges from the side of the pipe, filling the annular space. As a slurry is pumped through the tremie, the measuring rod or weighted measuring tape is slowly raised and lowered to detect and measure the depth of the slurry placement. Once the slurry is placed to the bottom of the auger column, the augers are retracted another 2-1/2 to 5 feet. Retracting the auger column with the winch line permits the option of pumping the grout through the tremie while the auger column is simultaneously withdrawn from the borehole. A quick-disconnect fitting can be used to attach the grout hose to the top of the tremie pipe. This fitting allows the grout hose to be easily detached from the tremie as individual 5-foot auger sections are disconnected from the top of the auger column. By successively retracting the auger column and pumping the grout into the annular space, the sealant is placed from the bottom of the annular space to the top. The tremie pipe can be moved upward as the slurry is placed or left in place at the bottom of the annulus until the annular seal is at the required height. Measurements of the depths of the annular seal are taken and recorded. Calculations of the volume of sealant needed and sealant used are recorded and any discrepancies are noted.

7.0 WELL DEVELOPMENT

The purpose of well development is to stabilize and increase the permeability of the gravel pack around the well screen, to restore the in-situ permeability of the formation which may have been reduced by drilling operations, to remove fine material that can pass through the filter pack and screen, and to ensure

that water within the well is representative of aquifer chemical characteristics. In simplest terms, well development consists of removal of water and sediment from the well.

Well development should continue until the groundwater discharge is visibly free of sediment and a sufficient amount of water has been purged from the well to ensure that all water introduced during drilling has been removed. For monitoring wells installed to communicate with glacial, alluvial, or other soils composed primarily of silt and clay-sized particles, it may not be possible to remove all sediments from the discharge water. Therefore, acceptable turbidity levels will be defined in these cases as groundwater that is reasonably free of sediment. This judgment will be site and, possibly, well specific.

Only one well development event is required before the well may be sampled. After these procedures have been completed, well purging immediately prior to sampling is sufficient to ensure collection of representative formation water acceptable for laboratory analysis in most cases.

The selection of the well development method used is based on the drilling methods, well construction and installation details, monitored formation characteristics, and equipment availability. If groundwater is known to be contaminated, choose a method that keeps the volume of water generated to a minimum. Any equipment introduced into the well during development should be decontaminated prior to and after use. The primary methods of well development are summarized in the next sections. The correct screen and filter sand sizes must be installed or development may never be completely successful.

7.1 Overpumping and Backwashing

This method alternately reduces water level at a high rate and then reverses the flow direction (backwashing) so that water is passing from the well into the formation. This back-and-forth movement of water through the well screen and sand pack removes the fine particles from the formation immediately adjacent to the well while preventing bridging of sand grains. Backwashing can be achieved by several methods including starting and stopping a pump intermittently to change water levels or forcing water into a well under pressure through a water-tight fitting. Care should be taken when backwashing using water under pressure not to apply too much pressure which could damage or destroy the well screen. Water and sediment are periodically removed from the well during this process by pumping or bailing and temperature, pH, specific conductivity, and turbidity can be measured using this water. Do not add water to a well unless specified in an approved work plan.

7.2 Mechanical Surging

This method forces water into and out of a screen by operating a plunger within the well casing. The tool used is a surge plunger (or surge block), which is approximately the same diameter as the well casing. The surge block is used to agitate the water, causing water to move in and out of the screen. This movement of water helps to pull fine-grained materials into the well where they may be removed by pumping or bailing, prevents bridging of sand particles in the gravel pack, and aids setting graded sand packs. There are two basic types of surge plungers: solid and valved. In formations with relatively high water yields, a solid plunger is most effective, as the surging action is greater. In formations with low yields, a valved surge plunger may be preferred, as solid plungers tend to force water out of the well at a greater rate than it will flow back in. Valved plungers are designed to produce a greater inrush than outrush of water during surging. Water should be removed from the well during surging; otherwise, the

fine-grained sediments will be forced back into the water-bearing unit instead of being removed – the object of the surging and development.

7.3 Compressed Air

Compressed air can be used to develop a well by either of two methods: backwashing or surging. Backwashing is performed by forcing water out through the well screen, using increasing air pressure inside a sealed well, then releasing the pressurized air to allow the water to flow back into the well. This method should only be performed with the water level above the top of the screen and the water level should not drop below the top of the screen.

Surging consists of alternately releasing large volumes of air suddenly into an open well below the water level to produce a strong surge by virtue of the resistance of water head, friction, and inertia. Purging the well is subsequently conducted using the air lift method. As in other development methods, water should periodically be removed from the well to reduce turbidity and to allow fresh formation water to enter.

8.0 WELL POINT INSTALLATION

Well points or "drive" points are usually composed of a stainless steel screen with an attached steel point at the bottom. The point is driven into the ground by placing a drive shoe on top of the screen or riser pipe then driven into the ground using a sledgehammer, air hammer, or hydraulic press. Sections of steel riser are attached to the screen in order to allow the point to be placed at greater depths. The screen may also be covered with an outer pipe which can be pulled back to expose the screen when the target horizon is reached. This prevents damage to or clogging of the screen during installation.

SOIL SAMPLING

1.0 PURPOSE

The objective of this SOP is to collect a soil sample that is representative of conditions as they exist at the site by selecting the appropriate sampling device(s); by taking measures to avoid introducing contamination as a result of poor sampling and/or handling technique; and by reducing the potential of cross contamination between samples.

Prior to conducting a soil sampling investigation, develop a sampling strategy based on the objectives of the investigation. After developing a soil sampling strategy, the appropriate equipment and techniques must be used to conduct the investigation. This section discusses the various soil sample collection methods, sample handling, and available sampling equipment which has been shown to be technically appropriate.

2.0 EQUIPMENT

Selection of equipment is usually based on the depth of the samples to be collected, but it is also controlled to a certain extent by the characteristics of the soil. Manual techniques and equipment such as hand augers are usually used for collecting surface or shallow, subsurface soil samples. Power-operated equipment is usually associated with deep sampling but can also be used for shallow sampling when the borehole begins to collapse or when the soil is so tight that manual sampling is not practical.

2.1 Precautions for Trace Contaminant Soil Sampling

All soil sampling equipment used for sampling trace contaminants should be constructed of inert materials such as stainless steel where possible. Pans used for mixing should be made of Pyrex® (or equivalent) glass. In no case will chromium, cadmium, galvanized, or plated equipment be used for soil sampling when trace levels of inorganic contaminants are of concern. Similarly, no painted or plastic equipment (other than disposable sleeves used in Geoprobe® sampling) may be used where trace levels of organic contaminants are of concern. Paint, scaly, or heavy rust and grease must be removed before use, most often by sandblasting the equipment. Ancillary equipment such as auger flights may be constructed of other materials since this equipment does not come in direct contact with the samples.

3.0 SAMPLING METHODOLOGY

This discussion of soil sampling methods reflects both the equipment used to collect the sample as well as how the sample is handled and processed after retrieval. Selection of equipment is usually based on the depth of sampling, but also controlled, to a certain extent, by the characteristics of the material. Simple manual techniques and equipment, such as hand augers, are usually selected for surface or shallow subsurface soil sampling. As the depth of the sampling interval increases, some type of powered sampling equipment is usually needed to overcome the friction induced by soil resistance and depth. The following is an overview of the various sample collection methods employed over three general depth classifications: surface, shallow subsurface, and deep subsurface. Any of the deep collection methods described may be used to collect samples from the shallower intervals.

3.1 Manual Collection Techniques and Equipment

These methods are used primarily to collect surface and shallow subsurface soil samples. Surface soils are generally classified as soils between the ground surface and 6 to 12 inches below ground surface.

The shallow subsurface interval may be considered to extend from approximately 12 inches below ground surface to a site-specific depth at which sample collection using manual methods becomes impractical.

Surface Soils

Surface soils may be collected with a wide variety of equipment, if constructed of appropriate materials. Spoons or hand-augers are typically used to collect surface soil samples. If a thick, matted root zone is encountered at or near the surface, it should be removed before the sample is collected. The collected soil is placed in a pan, thoroughly mixed and placed in the appropriate sample container(s). Section 4.0 contains specific procedures for collecting and handling soil samples for volatile organic compounds (VOCs) analysis.

Shallow Subsurface Soils

Hand augers may be used to collect shallow subsurface samples. Typically, 4-inch auger buckets with cutting heads are pushed and twisted into the ground, then removed as the buckets are filled. The auger holes are advanced one bucket at a time. The practical depth of investigation using a hand auger depends upon the soil properties. In sand, augering is usually easily performed, but the depth of collection is limited to the depth at which the sand begins to flow. At this depth, the borehole will usually collapse and cannot be advanced. Deeper sampling must be accomplished using power equipment. Hand augering may also be of limited use in tight clays or cemented sands. Regardless of the soil type, at depths approaching 20 feet, sidewall friction may become so severe that power equipment must be used.

Power augers may be used to advance the borehole where hand augers are impractical. Power augers are a sampling aid, not a sampling device, and can advance a borehole to approximately 20 feet, depending upon soil conditions.

If power augers are used to advance the borehole, care must be taken that exhaust fumes, gasoline, and/or oil do not contaminate the borehole. The soil sample may then be collected using a hand auger. After the sample has been collected, the borehole may again be advanced (if necessary), and additional samples collected. The auger bucket must be replaced between samples with a properly decontaminated auger bucket. When a new borehole is advanced, the entire hand-auger assembly must be replaced with a properly decontaminated hand auger assembly.

If the borehole is advanced using a hand auger, upon reaching the desired sampling depth replace the bucket with a properly decontaminated bucket. Then, collect the sample. After the sample has been collected, the borehole may be advanced (if necessary) with the bucket that was used to collect the sample. Each sample must be collected using a properly decontaminated bucket.

Before the soil is placed in a pan, remove the top several inches of soil to minimize the possibility of cross contamination of the sample from fall-in of material from the upper portions of the hole.

Once the soil is placed in a pan, it is thoroughly mixed and placed in the appropriate sample container(s). Section 4.0 contains specific procedures for collecting and handling soil samples for VOCs analysis.

3.2 Powered Equipment

Powered equipment may be used to acquire soil samples from any depth (surface, shallow subsurface, and deep subsurface). When power equipment is used to advance the borehole and collect the sample, care must be taken that exhaust fumes, gasoline, and/or oil do not contaminate the borehole and the sample. Among the common types of powered equipment used to collect subsurface soil samples are split-spoon samplers driven with a drill rig drive-weight assembly or pushed using drill rig hydraulics. continuous split-spoon samplers, direct-push rigs, and backhoes. The use of each of these is described below.

Drill Rigs

Drill rigs offer the capability of collecting soil samples from greater depths. For all practical purposes, the depth of investigation achievable by this method is controlled only by the depth of soil overlying bedrock, which may exceed 100 feet.

Split-spoon samplers are usually driven either inside a hollow-stem auger or an open borehole after the auger(s) have been temporarily removed. The spoon is driven with a 140-pound hammer through a distance of up to 24 inches and removed.

Continuous split-spoon samplers may be used to obtain 5-foot long, continuous samples approximately 3 to 5 inches in diameter. These devices are placed inside a 5-foot section of hollow-stem auger and advanced with the auger during drilling. As the auger advances, the central core of soil moves into the sampler and is retained.

Before the soil is placed in a pan, remove the top several inches of soil to minimize the possibility of cross-contamination of the sample from fall-in of material from the upper portions of the hole. Once the soil is placed in a pan, thoroughly mix and place in the appropriate sample container(s). Section 4.0 contains specific procedures for collecting and handling soil samples for VOCs analysis.

Direct-Push Rigs

This method uses a standard split-spoon modified with a locking tip which keeps the spoon closed during the sampling push. Upon arrival at the desired depth, the tip is remotely released and the push continued. During the push, the released tip moves freely inside of the spoon as the soil core displaces it. This technique is particularly beneficial at highly contaminated sites, because no cuttings are produced. The push rods are generally retrieved with very little residue resulting in minimal exposure to sampling personnel and reduced IDW.

Before the soil is placed in a pan, remove the top several inches of soil to minimize the possibility of cross contamination of the sample from fall-in of material from the upper portions of the hole. Once the soil is placed in a pan, thoroughly mix and place in the appropriate sample container(s). Section 4.0 contains specific procedures for collecting and handling soil samples for VOCs analysis.

Geoprobe® Large-Bore Soil Sampler

Geoprobe® offers several tools for soil sample collection. Among these are the Macro-Core® Soil Sampler and the large-bore and dual-tube soil sampling systems. The large-bore soil sampling system is

utilized for collection of surface and subsurface soil samples. The selection of this system does not preclude the use of the other systems at a future time. The large-bore sampler is a solid barrel, piston-sealed, direct-push device for collecting discrete interval samples of unconsolidated materials at depth. The sampler is approximately 30 inches (762 mm) long and has a 1.5-inch (38 mm) outside diameter. The large-bore sampler is capable of recovering a discrete sample core 22 inches x 1.0 inches (559 mm x 25 mm) contained inside a removable liner. Sample volume measures up to 283 ml. The liner is a 24-inch-long by 1.15-inch-OD (610 mm x 29 mm) removable/replaceable thin-walled tube that fits inside the large-bore sample tube. Liners facilitate retrieval of the sample and may be used for storage, when applicable. The large-bore soil sampler is pushed with 1.25-inch-diameter probe rod.

Special Considerations for Large-Bore Soil Sampling

Liner Use and Material Selection

Due to the mode of operation, the large-bore soil sampler must be used with a liner. Liners are available in the following materials: stainless steel, brass, cellulose acetate butyrate (CAB), and Teflon®. For the majority of environmental investigations, CAB liners are used.

Sample Orientation

When the liners and associated sample are removed from the sample tubes, maintain the proper orientation of the sample. This is particularly important when multiple sample depths are collected from the same push. Also, maintain proper orientation to define precisely what depth an aliquot was collected from. Maintaining proper orientation is typically accomplished using vinyl end caps. Convention is to place red caps on the top of liner and black caps on the bottom to maintain the proper sample orientation. Orientation can also be indicated by marking on the exterior of the liner with a permanent marker.

Backhoes

Backhoes may be utilized in the collection of shallow subsurface soil samples. Samples may be collected directly from the bucket, or the trench wall (subject to applicable safety procedures). The bucket must be free of rust, grease, and paint. Only soil which has not been in contact with the bucket may be sampled, unless the bucket has been decontaminated.

Trenches offer the capability of collecting samples from very specific intervals and allow visual correlation with vertically and horizontally adjacent material. The sample should be collected without entering the trench itself, if possible. To collect the sample without entering the trench, use a stainless steel scoop attached to rigid electrical conduit with a scoop bracket to "dress" (remove surface layer of soil smeared on the trench wall as the bucket passed) the wall of the trench. Replace the scoop with a decontaminated scoop. Collect the soil. Place the collected sample in a pan, thoroughly mix and place in the appropriate sample container(s). Section 4.0 contains specific procedures for collecting and handling soil samples for VOCs analysis.

4.0 SOIL/SEDIMENT SAMPLING METHOD (METHOD 5035)

The following sampling protocol is recommended for site investigators assessing the extent of VOCs in soils and sediments at a project site. Because of the large number of options available, careful coordination between field and laboratory personnel is needed. The specific sampling containers and sampling tools required will depend upon the detection levels and intended data use. Once this

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information has been established, selection of the appropriate sampling procedure and preservation method best applicable to the investigation can be made.

4.1 Equipment

Once the soil/sediment has been obtained, the EnCore™ VOC sampler, syringes, stainless steel spatula, standard 2-oz. soil VOC container, or pre-prepared 40-mL vials may be used/required for subsampling collection. The specific sample containers and the sampling tools required will depend upon the data quality objectives established for the site or sampling investigation. The various methods are described below.

4.2 Sampling Methodology – Low Concentrations

When total VOC concentrations in the soil/sediment are expected to be less than 200 µg/kg, the samples may be collected directly with the EnCore™ sampler or syringe. If using the syringes, the sample must be placed in the sample container (40-ml pre-prepared vial) immediately to reduce volatilization losses. The 40-ml vials should contain 10 ml of organic free water for an unpreserved sample or approximately 10 ml of organic free water and a preservative. The 40-ml vials should be prepared and weighed by the laboratory (commercial sources are available which supply preserved and tared vials). When sampling directly with the EnCore™ sampler, immediately cap the vial.

A soil/sediment sample for VOC analysis may also be collected with conventional sampling equipment. A sample collected in this fashion must either immediately be placed in the final sample container (EnCore™ or 40-ml pre-prepared vial) or an intermediate sample container with no head space. If an intermediate container (usually 2-oz. soil jar) is used, transfer the sample to the final sample container (EnCore™ or 40-ml pre-prepared vial) as soon as possible not to exceed 30 minutes.

NOTE: After collection of the sample into either the EnCore™ Sampler or other container, the sample must immediately be stored in an ice chest and cooled to a temperature of less than or equal 6° Celsius.

Soil/sediment samples may be prepared for shipping and analysis as follows:

EnCore™ Sampler - the sample may simply be capped, locked, and secured in a plastic bag.

Syringe - Add about 3.7 cc (approximately 5 grams) of sample material to 40-ml pre-prepared containers. Secure the containers in a plastic bag. Do not use custody seals on the container; place the custody seal on the plastic bag. Note: When using the syringes, no air is allowed to become trapped behind the sample prior to extrusion, as this will adversely affect the sample.

Stainless Steel Laboratory Spatulas - Add between 4.5 and 5.5 grams (approximate) of sample material to 40-ml containers. Secure the containers in a plastic bag. Do not use a custody seal on the container, place the custody seal on the plastic bag.

4.3 Sampling Methodology – High Concentrations

Based upon the data quality objectives and the detection level requirements, this high-level method may also be used. Specifically, the sample may be packed into a single 2-oz. glass container with a screw

cap and septum seal. Fill the sample container quickly and completely to eliminate head space. Soils/sediments containing high total VOC concentrations may also be collected as described in Section 4.2, and preserved using 10-ml methanol.

4.4 Special Techniques and Considerations

The following is the standard procedure for field cleaning augers, drill stems, rods, tools, and associated equipment. This procedure does not apply to well casings, well screens, or split-spoon samplers used to obtain samples for chemical analyses, which should be cleaned as outlined in Section 2.3.

Effervescence

If low concentration samples effervesce from contact with the acid preservative, then either a test for effervescence must be performed prior to sampling, or the investigators must be prepared to collect each sample, both preserved or unpreserved as needed, or all samples must be collected unpreserved.

To check for effervescence, collect a test sample and add to a pre-preserved vial. If preservation (acidification) of the sample results in effervescence (rapid formation of bubbles), then preservation by acidification is not acceptable, and the sample must be collected unpreserved.

If effervescence occurs and only pre-preserved sample vials are available, place the preservative solution into an appropriate hazardous waste container and triple rinse the vials with organic free water. An appropriate amount of organic free water, equal to the amount of preservative solution, should be placed into the vial. The sample may then be collected as an unpreserved sample. Accurately measure the amount of organic free water placed into the vials.

Sample Size

While this method is an improvement over earlier ones, field investigators must be aware of an inherent limitation. Because of the extremely small sample size, sample representativeness for VOCs may be reduced compared to samples with larger volumes collected for other constituents. The sampling design and objectives of the investigation should take this into consideration.

Holding Times

Field investigators should note that the holding time for an unpreserved VOC soil/sediment sample is 48 hours. Arrangements should be made to ship the soil/sediment VOC samples to the laboratory by overnight delivery the day they are collected so the laboratory may preserve and/or analyze the sample within 48 hours of collection.

Percent Moisture

Samplers must ensure that the laboratory has sufficient material to determine percent moisture in the VOC soil/sediment sample to correct the analytical results to dry weight. If other analyses requiring percent moisture determination are being performed upon the sample, these results may be used. If not, a separate sample (minimum of 2 oz.) for percent moisture determination will be required.

Safety

Methanol is a toxic and flammable liquid. Therefore, methanol must be handled with all required safety precautions related to toxic and flammable liquids. Avoid inhaling methanol vapors. Vials should be

opened and closed quickly during the sample preservation procedure. Methanol must be handled in a ventilated area. Use protective gloves when handling the methanol vials. Store methanol away from sources of ignition such as extreme heat or open flames. The vials of methanol should be stored in a cooler with ice at all times.

Shipping

Methanol and sodium bisulfate are considered dangerous goods; therefore, shipment of samples preserved with these materials by common carrier is regulated by the U.S. Department of Transportation and the International Air Transport Association (IATA). The rules of shipment found in Title 49 of the Code of Federal Regulations (49 Code of Federal Regulations parts 171 to 179) and the current edition of the IATA Dangerous Goods Regulations must be followed when shipping methanol and sodium bisulfate. Consult the above documents or the carrier for additional information. Shipment of the quantities of methanol and sodium bisulfate used for sample preservation falls under the exemption for small quantities. A summary of the requirements for shipping samples follows. Refer to the code for a complete review of the requirements.

- 1. The maximum volume of methanol or sodium bisulfate in a sample container is limited to 30 mls.
- 2. The sample container must not be full of methanol.
- 3. The sample container must be stored upright and have the lid held securely in place. Note that the mechanism used to hold the cap in place must be able to be completely removed so weight is not added to the sample container, as specified in Method 5035.
- 4. Sample containers must be packed in a sorbent material capable of absorbing spills from leaks or breakage of the sample containers.
- 5. The maximum sample shuttle weight must not exceed 64 pounds.
- 6. The maximum volume of methanol or sodium bisulfate per shipping container is 500 mls.
- 7. The shipper must mark the sample shuttle in accordance with shipping dangerous goods in acceptable quantities.
- 8. The package must not be opened or altered until no longer in commerce.

4.5 Summary

The following summary table lists the options available for compliance with SW846 Method 5035. The advantages and disadvantages are noted for each option. SESD's goal is to minimize the use of hazardous material (methanol and sodium bisulfate) and minimize the generation of hazardous waste during sample collection.

Option	Procedure	Advantages	Disadvantages
1	Collect 2 – 40-mL vials with ~5 grams of sample and 1 – 2 oz., glass with septum lid for screening and % moisture.	Screening conducted by lab.	Presently, a 48-hour holding time for unpreserved samples.
2	Collect 3 Encore [™] ; and 1 – 2 oz., glass with septum lid for screening and % moisture.	Lab conducts all preservation/preparation procedures.	Presently, a 48-hour Holding time for preparation of samples
3	Collect 2 – 40-mL vials with 5 grams of sample and preserve w/methanol or sodium bisulfate and 1 – 2 oz., glass with septum lid for screening and % moisture.	High-level VOC samples may be composited. Longer holding time.	Hazardous materials used in field.
4	Collect 1 – 2 oz., glass w/septum lid for analysis and % moisture.	Lab conducts all preservation/preparation procedures.	May have significant VOC loss.

Proprietary Information SEDIMENT SAMPLING

1.0 PURPOSE AND APPLICABILITY

This Standard Operating Procedure (SOP) describes the methods to be used to obtain sediment samples from lagoon, lake, river, and stream bottoms and estuaries. Sediment sampling is performed in order to define the chemical, physical, and/or biological composition of the sediment. Sediment techniques and equipment are designed to minimize effects on the chemical and physical integrity of the sample. The purpose of this SOP guidance is to ensure that representative sediment samples are obtained.

Sediment samples may be obtained directly from small streams using trowels or small shovels or from lakes and ponds using dredge/clam shell-type samplers. Sediment samples should not be collected from areas which may become exposed during low-flow or low-tide conditions.

Sediment samples collected for organic analyses may need to be taken from finer sediments, such as silt and clay. To collect such samples, sampling should be performed in areas of finer sediment deposition.

2.0 RESPONSIBILITIES

The Project Manager has the responsibility to identify the number and location of bottom sediment samples to be collected and the method of sample collection. The Field Team Leader is responsible for ensuring that samples are collected in accordance with instructions from the project scientist and to make changes in the methods, when necessary and appropriate.

3.0 REQUIRED MATERIALS

- Dredges (e.g., Ponar, Ekman, Peterson) and rope;
- Shovels, long and short-handled;
- Coring (tubes, augers);
- Trowels, plastic, and steel;
- Conduit pipe or equivalent, if extension is necessary to sample at depth;
- Sample bottles;
- Sampling implements (e.g., spoons, scoops, tongue depressors);
- Chest waders, hip boots;
- Boat:
- Gloves;
- Measuring tapes;
- Buckets;
- Distilled water;
- Labels;
- · Field notebook/data sheets;
- Safety gear (e.g., life jackets, rope);
- First-aid kit; and
- Chemical-free paper towels.

4.0 SAFETY PRECAUTIONS

The following discussion on safety is broken down into two cases: the first case is concerned with safely collecting samples when wading and the other when boating to collect samples.

4.1 Wading

Two people should be employed when collecting samples by wading unless the stream is small. Lake and pond shorelines may also be sampled by wading; two people should be used to sample and a safety line should be tied between them, with one person on shore at all times. Personal flotation devices should be worn when sampling in large streams and along lakes.

4.2 Boating

Cores or dredges are the most efficient means of sample collection from a boat or barge. There are numerous safety precautions which must be considered when using a boat or barge to collect samples. The following are some of the more important considerations:

- The sampling crew must be familiar with the safety regulations for the state and water body in which the sampling is to be done. A check with the appropriate regulatory agency is advisable before field sampling is initiated.
- Every person on board the boat should have and wear at all times a personal flotation device (life vest).
- Common sense should be employed at all times.

5.0 PROCEDURE

- 1. Review sampling plan to determine the proper location and method of sampling.
- 2. Determine depth of water at sample location. Enter depth into field logbook or on field data sheets.
- 3. Collect sample using selected equipment.

5.1 Non-Dredge Sampling

If the surface water body is wadable, the easiest way to collect a sediment sample is using a scoop or a spoon. Sampling is accomplished by wading into the surface water body and, facing upstream (if there is a current), scooping the sample from along the bottom of the surface water body in an upstream direction. Excess water may be removed from the scoop or spoon. Aliquots of the sample are then placed in a mixing pan or bowl, or placed into the sample container.

- 1. Fill sample jar(s) with sediment using a clean implement such as a scoop, spoon, or tongue depressor.
- 2. Label samples, place in coolers, and prepare for shipment to laboratory.
- 3. Complete chain-of-custody record.
- 4. Decontaminate sampling gear in accordance with the project-specific work plan.

5.2 Dredge Sampling

- 1. Repeat steps 2 and 3 of Section 5.0.
- 2. Secure rope to dredge.

- 3. Open dredge and lock into position.
- 4. Lower dredge and lock into position.
- 5. Close the jaws of the dredge by jerking the dredge rope once or twice.
- 6. Pull the dredge up through the water column at a steady, even pace and empty contents into a clean pan or bucket.
- 7. Repeat steps 3, 4, 5, and 6 if sediment recovery is inadequate.
- 8. Perform steps 2, 3, and 4 of Section 5.1.

5.3 Coring

Coring samples are used to collect vertical columns of sediment, and may be desired when historical information regarding sediment deposition is needed. This sampling method will preserve the sequential layering of the deposit, and when it is desirable to minimize the loss of material at the sediment-water interface. Several types of coring devices have been developed depending upon the depth of water from which the sample is to be obtained, the nature of the material, and the length of core to be collected.

Core sampling devices are particularly useful in environmental sampling because turbulence created by descent of the device through water is minimal, thus the fines of the sediment-water interface are only minimally disturbed. The sample is withdrawn intact, permitting the removal of those layers of interest. Core liners of glass or Teflon® can be obtained, thus reducing possible contamination. The samples are easily delivered to the laboratory in the tube in which they were collected.

A strong core tube, such as one made of aluminum, steel, or stainless steel is needed to penetrate the sediment or underlying clay or sands. The corer should have a check valve built into the driving head which allows water and air to escape from the cutting core, thus creating a partial vacuum to hold the sediment core in place. The corer device may be attached to a standard hand auger extension and handle.

- 1. Assemble core sampling device, with appropriate sampling tube, if necessary.
- 2. Push core tube into the substrate. When sampling coarse or hard substrates, a gentle rotation of the tube will facilitate greater penetration and decrease core compaction.
- 3. If the tube top end is above water, a cap may be placed over the top to provide a suction and reduce sample loss. The tube is slowly extracted with suction and adherence, keeping the sample in place. Before pulling the bottom of the core above water, it too should be capped.
- 4. Before extracting sediment from the coring tube, the water above the top of the sediment should be decanted. This is accomplished by turning the tube on its side, and gently pouring until fine sediment particles appear.
- 5. Following extraction of the core sample, the core may be logged and appropriate intervals sampled for analyses. Screening for volatile organic vapors may be conducted using a PID or other instrument.

6.0 QUALITY CONTROL

Sufficient decontaminated sampling devices should be brought to the field; however, if a sampling device is to be used at more than one location, the device should be decontaminated in accordance with the project plan. Chain-of-custody records should be maintained. Samples should be placed on ice and kept cool at about 4°C as soon as possible after collection and remain cool until their arrival at the laboratory.

7.0 DOCUMENTATION

A field record of sampling activities will be kept. The record of sampling activities should be in sufficient detail to allow the project scientist/engineer to understand how and where sediment samples were taken. A copy of the field record will be maintained in the project file.

GROUNDWATER SAMPLING FROM MONITORING WELLS

1.0 PURPOSE

This Standard Operating Procedure (SOP) will be used in preparing for and executing groundwater sampling from wells. The procedures describe recommended methods for obtaining representative groundwater samples for organic, inorganic, and/or other general chemistry parameters. This SOP is based on United States Environmental Protection Agency and other guidelines and is intended to provide general procedures for groundwater sampling. Any exceptions are to be documented in the Site Quality Assurance Project Plan (QAPP) and Sampling and Analysis Plan (SAP).

This SOP addresses the three major phases for the implementation of a field groundwater sampling program: pre-field or office activities; on-site purging and sampling activities; and post-sampling activities. Each phase is addressed, herein, first by briefly describing the general tasks that must be considered and then by detailing procedures to be followed in implementing each phase.

2.0 PRE-FIELD/OFFICE ACTIVITIES

2.1 Summary of Tasks to be Performed

To aid in the preparation of a field sampling event, a site-specific Pre-Field Check List for Sampling Activities and an equipment checklist are used. The Field Team Leader is responsible for ensuring that all items on the checklist are completed in a timely manner before the sampling event occurs. Verifying completion of the tasks will be documented by the Field Team Leader or his/her designee by initialing the equipment checklist in the space provided.

2.2 Office Activities Procedures

2.2.1 Analytical Laboratory(ies)

Notification of the analytical laboratory(ies) of the sampling event and anticipated schedules are performed by the Project Manager. However, verification should be completed by the Field Team Leader. The Project Manager will complete an analytical request that specifies the project name, schedule, laboratory, sample locations, matrix, number of samples, analytical parameters, quality assurance/quality control (QA/QC) requirements and frequency, and sample bottle delivery location. Any QA samples requiring laboratory-grade water will be specified. The analytical request form will then be submitted to the laboratory and the Field Team Leader.

To ensure analyses occur within the requisite holding times, the Project Manager will coordinate with the laboratory to schedule sample receipt, which allows scheduling of field sampling activities, sample shipment, and delivery. The Project Manager should also determine the frequency of submittal of laboratory-required QA samples, such as matrix spike and matrix spike duplicate samples.

2.2.2 Notification of Facility and Regulatory Agency Personnel

Prior to each sampling event, the Project Manager will notify the appropriate client contact and appropriate regulatory personnel, if any, of the proposed sampling date in writing. This notification is to allow scheduling of sampling oversight and any coordination with plant operations.

2.2.3 Project-Specific Plans

Prior to initiating sampling activities, all field personnel are responsible for reviewing the project-specific Health and Safety Plan, Work Plan, Analytical Request Form and pertinent SOPs to ensure that the objectives of the groundwater monitoring and sampling program are attained in a safe and timely manner. Groundwater sampling personnel should have access to a map showing well locations, and confirm access to well locations (i.e., access agreements, keys to well locations, etc.)

The Field Team Leader should determine the methods for handling the investigation derived waste (IDW) generated and, as necessary, procure appropriate containers for purge water.

The project-specific Work Plan will dictate the QA/QC samples that are needed. The QA/QC samples most often included in groundwater sampling programs are described in Section 3.8.

2.2.4 Sample Bottles and Shipping Containers

The number, type, and size of bottles are determined based on the scope of work. The laboratory performing the analyses will provide and ship bottles to the site or other designated location. The laboratory will also provide the appropriate type and amount of preservatives for the analyses to be performed, and laboratory-grade water, as specified in the analytical request. The laboratory is to provide an extra bottle allowance for breakage or additional sampling. The appropriate QA/QC sample bottles should also be included.

2.2.5 Assemble Sampling Equipment

The appropriate quantity and type of equipment will be determined from the project work plan. The Field Team Leader and technicians will perform the function of preparing and checking the equipment. The completed equipment checklist and Pre-Field Check List for Sampling Activities should be reviewed by the Field Team Leader.

The calibration of meters will be performed prior to use in the field. Once in the field, the meters will be recalibrated. Section 3.2 contains general information regarding instrument calibration.

3.0 ON-SITE ACTIVITIES

3.1 Summary of Tasks to be Performed

The procedures for groundwater sampling are presented herein. The tasks highlighted in this section include:

- Meter calibration:
- Water level measurement procedures;
- Well purging procedures;
- Groundwater sampling procedures;
- Filtering procedures;
- Field QA/C requirements;
- Documentation; and
- Safety precautions.

During well purging and sampling activities, there are several basic procedures which must be completed for QA purposes.

- New sampling gloves should be worn at each well location;
- Wells should be sampled in the order of least impacted to most impacted, starting with upgradient wells; and
- Equipment cleanliness should be maintained and, if necessary, a new sheet of plastic surrounding or to the side of the well may be used to eliminate equipment contamination from the ground surface.

3.2 Calibration of Meters

At a minimum, temperature, specific conductance, and pH will be measured during and at the completion of well purging. Since stabilization of these groundwater indicator parameters is often used to evaluate the adequacy of the purging procedure, properly calibrated equipment is essential to collect valid data.

3.2.1 Specific Conductance Meter

Conductivity is defined as the ability to conduct or transmit an electrical current. Most specific conductance meters use a conductivity bridge where a voltage is applied, and the current is measured. Conductivity units are measured in micromhos per centimeter (umhos/cm) or microsiemens per centimeter (uS/cm) at 25°C. Results are reported to the nearest ten (10) units for readings less than 1,000 umhos/cm at 25°C and to the nearest hundred (100) units for readings greater than 1,000 umhos/cm at 25°C. All calibration information is recorded in the site-specific field logbook. Calibration of the specific conductance (conductivity) meter is to be conducted in accordance with the owner's manual at the beginning of the day and at the end of the daily sampling.

3.2.2 pH Meter

The pH is defined as the negative logarithm of the effective hydrogen ion concentration or hydrogen ion activity in gram equivalents per liter on a scale which ranges from 0 to 14, with 7 representing neutrality. The pH meter is to be equipped with automatic temperature compensation. The meter may also have the capability of measuring oxidation reduction potential (ORP). All calibration information is to be recorded in the site-specific field logbooks. Units of pH are Standard Units (SU) and should be read in one-hundredth (0.01) of a unit.

The calibration of the pH meter is to be conducted on a daily basis in the field. At the beginning and end of the day, the meter is to be checked against three standard buffer solutions that span the pH range (e.g., 4.0, 7.0, and 10.0). While in the field, the meter is to be periodically checked against one or more buffer solutions, as necessary. The pH meter is to be prepared and used in accordance with the owner's manual.

3.3 Water Level Measurement

Water levels in monitoring wells must be measured before the wells are purged and sampled. Several methods may be used when measuring the water levels in wells. Regardless of the method of water level measurement, the upgradient well(s) should be measured prior to the downgradient. When performed in conjunction with decontaminating the measuring device between wells, the potential for cross

contamination will be further reduced. Protective gloves are to be worn during water level measurements. All in-well measurements (depth to water, total well depth) levels are referenced from a surveyed point at the top of each well casing and measured to an accuracy of .01 feet.

The following methods will obtain accurate water level and depth measurements, and will also minimize the chance of cross contamination.

3.3.1 Electronic Water Level Indicator

This instrument consists of a spool of dual conductor wire, with a probe attached at one end of the wire, and an indicator containing a low-voltage electrical source at the other end. The wire is typically sheathed with a graduated measuring tape marked on the tap cover. When the probe comes in contact with water, an electronic circuit is closed, which is indicated by a tone and/or light in the indicator. The total depth of any well measured using a water level indicator should be corrected for any length of the probe that extends below the probe's circuit bridge. All measurements should be recorded to one-hundredth (0.01) of a foot.

Use of electronic water level indicators should be limited to those wells not containing hydrocarbon liquids. The electronic water level indicator can generally be used at most well locations. Groundwater at some locations may have low concentrations of dissolved ions that do not conduct the electrical current emitted by the probe.

The procedures for using an electronic water level indicator are as follows:

- 1. Lower the weighted probe into the well casing. When the probe contacts water, a tone will be heard. Observe the calibrated tape to determine the water level.
- 2. Measure and record the reading to the nearest 0.01 foot.
- 3. Continue to lower the probe into the well casing to determine the total depth of the well, if needed.

 The measurement is typically accomplished by determining the point where tension is felt on the tape when raising the probe from resting on the bottom of the well. Measure and record total depth.
- 4. Decontaminate the probe and submerged portion of tape between each well by rinsing with distilled water and wiping the line with a clean cloth.

3.3.2 Interface Probe

Oil/water interface probes are commonly used to detect the presence of any floating or sinking non-aqueous phase liquid (NAPL) layers, as well as the water levels inside the well. An interface probe typically uses an optical sensor to determine when the probe is in NAPL and a conductivity sensor to determine when the probe is submerged in water. Each phase may be measured separately.

When highly volatile vapors may be present, an interface probe with a grounding clamp should be used.

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The procedures for using an interface probe are listed below:

1. The probe should be lowered slowly inside each well. If water is detected, the probe will sound a tone (beeping) to signify the beginning of the water level.

When a floating layer is encountered, a different (continuous) tone sounds. After recording the depth of the top of the floating NAPL, continue lowering the probe (observing the calibrated tape) until the steady tone stops at the LNAPL/water interface. Record this depth. The measurements on the drop line between when the steady tone began and when it stopped will determine the thickness of the NAPL layer.

- 2. The procedure as described above can also be used to determine the presence (and thickness) of dense (sinking) NAPL layers, except that the bottom of the well will indicate the bottom of the layer.
- 3. All measurements should be recorded to the nearest one hundredth (0.01) of a foot.
- 4. The probe is decontaminated between each well by rinsing with distilled water, or hexane if NAPL layers are present, and then wiping with a clean cloth.

3.4 Well Purging

Monitoring wells are purged of water contained in the well prior to sample collection to assure collection of groundwater samples representative of actual water-bearing zone conditions. Two methods for determining adequacy of purging are provided below.

3.4.1 Conventional Well Purging

Typically, using conventional well purging methods, the wells should be purged a minimum of three well volumes until a maximum of five well volumes of standing water has been removed or until the pH, conductivity, and temperature of the purge water stabilizes. A combination of these methods is typically used, where increments of well volumes are monitored for stabilization.

The flow rate of pumps used for purging should be able to be regulated and maintained at a low rate to avoid causing turbidity in samples. The rate of pumping during purging should be less than the rate used for development. Similarly, the use of a bailer during purging should not cause turbidity and should not drop to the water surface. Attempts should be made to avoid purging wells to dryness. This can be accomplished by pumping at a low flow rate. If a well is pumped dry, water than enters the well in an evacuated condition may cascade across the well screen and reduce volatile organic compound (VOC) concentrations and/or introduce fine particles into the water column.

In some situations, even with low flow rates, a well will be pumped or bailed dry (i.e., low-yield bedrock wells or low permeability sediments). In these situations, this generally constitutes an adequate purge and wells can be sampled following sufficient recovery (i.e., sufficient volume to fill all sample containers). Purging three well volumes is not necessary. The pH, temperature, and specific conductance should be measured during the collection of the sample from the recovered volume as the measurements of record for the sampling event.

To calculate the amount of water to purge from each well, the depth of standing water must be measured, and the well casing diameter and screen length of each well must be known. This information, along with the following appropriate formulas, is used to determine the volume to be purged from each well.

The following formula may be used to determine the volume of any well:

$$V = 5.875 \times C^2 \times H$$

where:

V = volume in gallons

C = casing diameter, in feet

H = height of water column, in feet

Using this formula, the volume per linear foot of well casing of common casing sizes is listed below:

Casing Diameter (inches)	Volume per Linear Foot (gallons)	
1.5"	0.092	
2.0"	0.163	
4.0"	0.563	
6.0"	1.469	

The minimum purge volume required is three times the standing water volume in the well. Between the purging of three to five well volumes, groundwater purge parameters (pH, specific conductance, and temperature) are measured to determine whether adequate purging has occurred through the stabilization of purge parameters. Stabilization monitoring should occur during purging at regular intervals of the standing water volume. As general criteria, three successive readings should be within ± 0.1 for pH and $\pm 3\%$ for conductivity.

To verify the removal of the required water volume during purging, a graduated bucket is used to measure flow rate during pumping or purge water volume. Purge water will be contained as IDW for proper disposal.

3.4.2 Low-Flow Purging and Sampling

The low-flow purging method is an alternative to the conventional method of purging multiple well volumes. Low-flow purging focuses on pumping a monitoring well from the well's screen interval at a flow rate that is less than the recharge capacity of the formation. The rate of pumping is generally specific to the water-bearing unit, but typically does not exceed one liter per minute (or equivalently, 0.26 gallon per minute). By purging at low flow rates, only groundwater that enters through the well screen is purged from the well. Because stagnant water located above the pump intake is not drawn down into the pump, the casing volume would not have to be purged from the well prior to sampling.

Groundwater samples are generally collected during low-flow purging as soon as formation water is determined to be flowing from the well. Therefore, it is important to recognize the difference between stagnant water from casing storage and recharged formation water. The volume of water purged from a well is solely dependent on formation water stabilization rather than predetermined well volumes. Low-flow purging can significantly reduce the volume of water removed during sampling.

Objective

The overall objective of low-flow purging is to match the purging device intake velocity with the natural groundwater velocity and thereby reduce sample disturbance. This is most easily evaluated by monitoring drawdown in the well and adjusting flow rate to minimize or eliminate that drawdown. Research has shown that purging with various types of pumps (peristaltic, low-speed submersibles, and bladder pumps) does produce low turbidity and high-quality samples (Puls and Barcelona, 1989, Puls et al., 1992; Backhus et al., 1993; Barcelona et al., 1994).

With low-flow purging, the purge volume or purge duration is evaluated through continuous monitoring of water quality parameters, such as specific conductance, oxidation-reduction (redox) potential, dissolved oxygen (DO), pH and turbidity. Upon equilibration of these parameters, it is assumed that formation water is being accessed and sampling can be initiated.

Since the low-flow purging method is based on minimal disturbance, the total depth of the well should be measured after completion of groundwater sampling.

Procedures

All equipment cleanliness should be maintained and, if necessary, should be laid on clean plastic sheeting placed around or beside the well. The pump or tubing connected to a peristaltic pump is set with the intake at the mid-point of the screen interval, preferable in advance of the sampling event at the well.

Upon initiation of pumping, the flow rate is to be measured using an appropriate graduated container, preferably one liter or one quart. The flow rate should be adjusted to approximately one liter per minute. The water level should be checked periodically as a guide to flow rate adjustment. Collect the purge water as IDW.

Optimally, an in-line water quality measurement device should be used to continuously monitor groundwater quality indicator parameters. The water quality indicator parameters can include pH, ORP, specific conductance, DO and turbidity. The last three parameters are often the most sensitive. Measurements should be taken every three to five minutes, if the above suggested rate is used. Stabilization is achieved after all parameters have stabilized. Three successive readings should be within ±0.1 for pH, ±3% for conductivity, ±10 mv for ORP, and ±10% for turbidity and DO. Stabilized purge indicator parameter trends are generally obvious and follow either an asymptotic or exponential change to table valves. DO and turbidity usually require the longest time for stabilization.

Upon parameter stabilization, sampling can be initiated. If an in-line device is used to monitor water quality parameters, disconnect or bypass the device during sample collection. Sampling flow rate may remain at the established purge rate or altered to minimize aeration, bubble formation, turbulence in sample bottles, or loss of volatile constituents due to extended residence time in tubing. Typically, flow

rates less than 0.5 L/min are appropriate. The same device should be used for sampling as was used for purging. Groundwater sampling should proceed by collecting groundwater samples in appropriate containers, and preserving the samples, as necessary.

3.5 Conventional Purging and Sampling Methods

Wells may be purged and sampled by either hand bailing or pumping. When possible, all samples are collected using laboratory cleaned bailers. Hand bailing for sample collection is preferred because bailers may be decontaminated more effectively than pumps. Also, degassing of VOCs may occur through the use of some types of pumps.

If NAPLs are present in the well, pumping with a peristaltic pump will be the preferred purge method. This method should reduce mixing of the NAPL within the water column. The effectiveness of peristaltic pumps is generally limited to wells with water levels less than 25 feet below the top of the casing.

3.5.1 Bailing

The following procedures describe the techniques to be used when wells are purged and samples are extracted using hand bailers.

- 1. If necessary to maintain equipment cleanliness, place plastic sheeting (or garbage bags) around the well casing to create a clean surface for the placement of sampling cord and equipment.
- 2. Use a disposable, dedicated, or new/decontaminated bailer on each well for the required purging and sampling. Each bailer will be constructed of stainless steel, Teflon®, polyvinyl chloride (PVC) or high density polyethylene (HDPE).
- 3. Use new surgical or nitrile gloves when working at each well.
- 4. Use new nylon or polypropylene cord to tie to the top of the bailer. Make sure the knotted cord is securely tied.
- 5. After attaching the cord to the bailer, lower it into the well until it touches the bottom. It is critical that the bailer be slowly and gently immersed into the top of the water column, allowed to fill and removed. Then remove an additional length of cord and tie it securely to the wellhead to serve as a safety line for the bailer.
 - If an NAPL layer is present, either remove the LNAPL with a bailer or see Section 3.5.2 for purging with a pump. If a sinking NAPL layer exists and pumping is not feasible, lower the bailer so as to avoid mixing of this layer within the well water column, i.e., the bailer will not be lowered into the sinking NAPL layer. If the dense NAPL is to be removed, it should be conducted after groundwater sampling is completed.
- 6. When raising the bailer, collect the cord on the plastic sheeting or in a plastic-lined, five-gallon bucket. Collect the purge water as IDW.

- 7. When sampling for VOCs, the sample aliquot is to be removed from the bottom of the bailer through the use of a dedicated or decontaminated bottom emptying device.
- 8. A separate laboratory-cleaned stainless steel or Teflon® bailer may be used to collect samples from each monitoring well.
 - Samples are collected when the well recharges after purging;
 - All samples are collected according to their order of volatilization; and
 - All volatile organic samples will be collected with a laboratory cleaned, bottom-filling bailer in a manner which will prevent degassification of volatile organic constituents that may be present in the groundwater.
- 9. Preserve the samples as necessary and place them in ice chests and cool to a temperature of 4°C.
- 10. Before the cooler is sealed, a chain-of-custody sheet is completed for each cooler containing samples.
- 11. Each cooler is sealed, with chain-of-custody tape or a tag, and shipped or delivered to the laboratory for analysis.

3.5.2 Pumping

There are circumstances when pumps are more effective purging devices than bailers. Preferable, purge wells containing NAPL layer(s) with a pump to help reduce the mixing of this material in the water column. Also, in some instances, pumps are the only means by which samples can be extracted from monitoring wells.

Several pumps which are frequently used to purge and sample wells are discussed below.

Peristaltic Pump

Peristaltic pumps must be operated above ground, next to the well being purged, and are limited to purging depths of 20 to 30 feet below ground surface. The flow rate of peristaltic pumps is typically ariable by altering the pump head speed, and may achieve flow rates of 140 to 1,700 ml/min. The following procedures are used in operating a peristaltic pump.

- 1. New suction line is used on each well being purged. New medical-grade silicon pump head tubing will also be used if the pump is utilized for sampling.
- 2. If the sample is collected directly from the pump discharge, the choice of tubing used to collect the sample will be contingent on the parameters of interest.
 - Standard polyethylene tubing is sufficient to collect the sample for conventional and inorganic parameters.
 - Teflon® tubing may be used to collect samples to be analyzed for volatile and/or semi-volatile parameters.

- 3. Lower the suction line to a depth in the water column that assures continued collection. The intake of the suction line should be placed to avoid disturbing any NAPL layer. If a floating NAPL layer is encountered, this should be either suctioned off with a pump or removed with a bailer during purging. If a sinking NAPL layer is encountered, the suction line should be placed to avoid this layer regardless of well water drawdown. The suction-line assembly is dedicated for use on one well only. After use, the tubing is wrapped, marked, and stored for future use in the well to which it is dedicated. Otherwise, the tubing is discarded as IDW.
- 4. Monitor the pumping to ensure proper pump operation and assure continuous discharge. If drawdown occurs, lower the tubing deeper into the water column.
- 5. When the required amount of water is purged from each well, allow for sufficient recovery before sampling. If a floating NAPL was removed during purging, the suction line should be changed for sample collection.

Bladder Pumps

The bladder pump is a gas-operated, positive-displacement, submersible well pump that uses inert compressed gas, e.g., nitrogen, to inflate an internal bladder which pumps water up to the discharge line. These pumps can be used when large volumes of water must be purged from monitoring wells or when slow purge rates are desired. Usually these pumps are used on wells with depths up to 150 feet.

The line assembly is dedicated for use on one well only. After use, the tubing is wrapped, marked, and stored for future use in the well to which it is dedicated. Otherwise, the tubing is discarded as IDW.

Bladder pumps are primarily used to remove the required amount of water from the monitoring well prior to sampling. When this is accomplished, groundwater may be sampled using the bladder pump or using a laboratory-cleaned stainless steel bailer.

- 1. Connect the line assembly to the pump by first attaching the cable and then connecting the water and pneumatic lines.
- 2. Lower the pump down the well by unrolling the line off the spool. Lower the pump to the desired position inside the well, allowing sufficient room for drawdown of the water column.
- 3. Secure the cable to hold the pump at the desired depth.
- 4. Connect the gas line to the control box. The discharge line should be placed in a container (e.g., 55-gallon drum) to collect the purged water as IDW.
- 5. Connect the gas supply to the control box and adjust the pressure according to the manufacturer's manual.
- 6. Turn on the control box and adjust the inflate delay to obtain the optimal pumping cycle.

- 7. The pumping rate should be calculated to determine the length of time the pump should run to purge the well. Field measurements of pH and specific conductance, or the calculation of three casing volumes may be used to determine when a sufficient amount of water has been purged.
- 8. When the sufficient amount of water has been purged, the well may be sampled using the bladder pump at a low flow rate or using a laboratory-cleaned stainless steel bailer.
- 9. As noted, the tubing is used on only one well and after each sampling it is packed, sealed, and stored for future use on that well.

Submersible Pumps

For large-diameter wells or wells with depths greater than 150 feet, submersible pumps are used to purge the required amount groundwater. The submersible pumping apparatus may be removed to allow for sampling with a bailer, or the submersible pump assembly will remain intact and will be used to collect the sample. The flow rate of submersible pumps may be changed using a pump controller.

When possible, the submersible pumps will be dedicated to each well. However, this may not be economically feasible and the same pump must be used in several wells. In this instance, the pump must be decontaminated with a non-phosphate soap and water wash between each well. The pumps may be steam cleaned between wells, if the equipment is available.

- 1. Connect the pump to the discharge tubing. The discharge tubing used may be constructed of polyethylene or Teflon®, depending on the analytes of interest. The submerged portion of tubing may need to be of Teflon® construction.
- 2. The submersible pump should be lowered to a depth of approximately the middle of the screened portion of each monitoring well. The safety line should be secured to the well casing.
- 3. Connect the power cord to the power source (generator) and turn on the pump.
- 4. Monitor the pumping rate and lower the line if drawdown of the water column occurs.
- 5. If the well is pumped dry, allow sufficient time for the well to recover prior to sample collection.

3.6 Sample Collection

Groundwater samples should be decanted from the sample collection device (bailer or tubing) directly into the appropriate sample container. Samples are to be collected in order of volatilization and preserved. New surgical gloves, or the equivalent, must be worn for each well location.

3.7 Sample Filtration

Filtering will not be performed on samples to be analyzed for organics. Specific project filtering requirements will be outlined in the project work plan.

Filtering will be performed using peristaltic pumps with disposable 0.45 micron filters and disposable tubing. After filtering, samples requiring preservation are preserved and all containers are securely placed in coolers and chilled to a temperature of $4 \pm 2^{\circ}$ C.

3.8 Quality Assurance/Quality Control Samples

Field QA samples are an integral part of a groundwater sampling event. Sample integrity is verified by collecting duplicate analysis and blank samples (trip and equipment). The following samples will be addressed as required by the associated QAPP:

Trip Blanks

A trip blank consists of sample bottles (40-ml vials) filled with laboratory-grade water. Trip blanks are transported to and returned from the sampling location and delivered to the lab in the same manner as containers used for the field samples. At no time are trip blanks to be opened.

Trip blanks are generally analyzed for volatile organic constituents only; however, the project work plan should be reviewed to ensure trip blanks are not required for other analyses. Constituents found in the trip blank could be attributed to:

- 1. Interaction between the sample and the container,
- 2. Contamination in the laboratory water, or
- 3. Handling procedures that alter the sample analysis results.

Equipment Blanks

Equipment blanks are intended to ensure that the sampling devices have been appropriately cleaned (in the lab or field). To prepare an equipment blank, the sampling device should be filled with distilled water (or water poured through or over), then poured (or transferred) into the containers and delivered to the laboratory for analysis. The project-specific work plan or field sampling plan will dictate the frequency of equipment blank samples and the analyses to be performed.

Field Duplicates

Field duplicates are intended to ensure that the sampling procedures result in consistent and repeatable laboratory analysis results. A field duplicate is a sample collected by the same team or by another sampler or team at the same place, at the same time, using the same equipment, the same type of bottles, the same preservatives, and the same shipping protocol. It is used to estimate sampling and laboratory analysis precision. The project-specific work plan or field sampling plan will dictate the frequency of duplicate samples and the analyses to be performed.

3.9 Documentation

A number of documents must be completed before, during, and after each sampling project. These documents include: field logbooks, site data sheet forms, chain-of-custody sheets, field data sheets, and any project notes pertaining to the sampling work. Additional documents are used as reference information during each phase of a project and they include: holding time sheets, and sample preservation and containment sheets.

Site Data Sheets

The site data sheet is completed by the Project Manager or project engineer/scientist and submitted to the sampling team when requesting sampling work. These sheets contain the specific parameters of interest for which the collected samples will be analyzed. The Project Manager or Field Team coordinator must send the site data sheet to the laboratory to obtain the appropriate sample containers.

Field Logbook

A site-specific logbook will be used for documentation while in the field for all notes. Each page of the logbook should be numbered and dated. The entries should be legible and contain accurate and inclusive and should include, at a minimum, the following information:

- Identification of logbook ownership on the inside front cover, and telephone number.
- · Site name and location.
- Names of field personnel at the site, including daily safety meeting.
- Weather information (general).
- Sample locations and activities.
- Sample collection equipment.
- Calculations, results, and calibration data from field sampling equipment, field analytical equipment, and field physical parameters.
- Date, time, and method of monitoring well purging.
- Date, time, and method of groundwater sampling.
- Diameter of wells.
- Total depth of wells (to 0.01 foot).
- Distance to water in each well (to 0.01 foot) and volume of standing water in each well.
- Detection/amount of product in each well, if any.
- Water quality measurements (field) measured in increments during well volume purging, including, but not limited to: pH, specific conductance, and water temperature.
- Visual observations of the purge/sample water (i.e., turbidity, color).
- Observations of well integrity (i.e., conditions of casing, lid, pad, or lock).
- Collection of field quality assurance samples (i.e., blanks, split samples, or duplicates).
- Maps or sketches of sample locations.
- Regulatory agency personnel observing sampling or obtaining split samples.
- Documentation of sample shipment dates, time, and carrier tracking (air bill) number.
- Photograph information, including date and time, and brief description of what the photograph is intended to show.

Chain-of-Custody Forms

Chain-of-custody forms will accompany all samples shipped to the laboratory. This form contains information pertaining to the samples, such as: the project name; the signature of the people collecting the samples; the site of collection; the date and time of collection; the parameters of interest for each sample; remarks or observations of samples, if appropriate; the signature of the person relinquishing control of the samples; and the name of the carrier shipping the samples to the laboratory (e.g., Federal Express, UPS, etc.). The original chain-of-custody sheet is sent with the samples, and at least one copy is retained for the project files.

4.0 POST-SAMPLING ACTIVITIES

4.1 Summary of Post-Sampling Activities

The post-sampling activities involve:

- Completion of Field Data Sheets from the field notes;
- Completing the Trip Report; and
- Updating the Site-Specific Field Sampling Manual (as necessary).

4.1.1 Trip Report

The Field Team Leader is responsible for a brief summary of the sampling event, prepared to serve as a cover page for all project-specific data, such as:

- Field notes:
- Chain-of-custody sheets; and
- Other pertinent information, as necessary.

The Field Team Leader is responsible for submitting the Trip Report to the Project Manager, geologist/engineer, and other pertinent team members upon completion of the sampling event.

4.1.2 Site-Specific Field Sampling Manual

Any new site-specific considerations that need to be updated, to account for equipment/bottle/procedures changes (i.e., a well is damaged and must be sampled with a pump, etc.), will be adjusted in the site-specific manual.

Proprietary Information SOIL GAS SAMPLING

1.0 PURPOSE

The objective of this SOP is to collect soil gas samples according to the protocols described by the Pennsylvania Department of Environmental Protection's Technical Guidance Manual (PA Bulletin, January 24, 2004), ASTM International Method D5314-92, and the United States Environmental Protection Agency's (U.S. EPA) Environmental Response Team.

Prior to conducting a soil gas sampling investigation, a sampling strategy should be developed based on the objectives of the investigation. After developing a soil gas sampling strategy, the appropriate equipment and techniques must be used to conduct the investigation. This section discusses the various soil gas sample collection methods, sample handling, and available sampling equipment which has been shown to be technically appropriate.

2.0 SAMPLING METHODOLOGY

Soil gas samples can be collected using several different sampling techniques. Two of which are discussed below; the use of the Geoprobe® Post-Run Tubing (PRT) System and the installation of soil gas collection implants.

Direct-Push Soil Gas Sampling Technique

The direct-push Geoprobe® PRT System can collect a soil gas grab sample. This method is appropriate for collecting one representative soil gas sample from a given location.

The PRT System provides a vacuum-tight seal that prevents sample contamination and ensures the sample is collected from the desired depth. The PRT method utilizes an expendable drive point that is advanced to the desired sampling depth. As part of this method, a small-diameter boring is completed with the use of the Geoprobe® rods, either adjacent to or through the building's foundation, into the underlying vadose zone. If the PRT boring is completed outside the building, it must be within 5 feet horizontally of the building's foundation to evaluate the indoor air quality.

A PRT Expendable Point Holder is attached to the bottom of the probe rod, which holds the point in place until it reaches the desired depth. The probe is then retracted approximately one foot upward, leaving the drive point in the ground and creating a void space in the subsurface soil where soil gas can accumulate. The PRT Expendable Point Holder is equipped with a barbed fitting and O-ring. A PRT Adapter is inserted onto 1/4-inch polyethylene tubing. The PRT Adapter is then threaded onto the barbed fitting and O-ring on the PRT Expendable Point Holder, to ensure that no atmospheric air can contaminate the sample. The sampling equipment and tubing is purged to rid the tubing of atmospheric air and allow the subsurface soil gas to enter the probe sample tubing. This is achieved by either connecting the end of the sample tubing to a tedlar bag placed in a vacuum box or to a graduated plastic syringe. Calculate the volume of air in the tubing assembly based on the length of tubing used. The purging device should then be used to remove one to three volumes of air in the sampling equipment. Once the tubing has been satisfactorily purged to enable collection of a representative soil gas sample, a 1-liter to 6-liter preevacuated, SUMMA® canister is attached to the end of the tubing for sample collection. The sample is sent for laboratory analysis of volatile organic compounds (VOCs) by U.S. EPA Method TO-14 or TO-15. After sample collection, the boreholes are filled with bentonite chips to the surface and hydrated.

Semi-permanent Soil Gas Implants

Another method which can be used to collect soil gas samples is semi-permanent soil gas collection implants. This method allows for multiple rounds of soil gas sampling over time from a given location.

As part of this method, a small-diameter boring is completed with the use of the Geoprobe® rods and anchor point, either adjacent to or through the building's foundation, into the underlying vadose zone. Once the desired depth is achieved, an implant constructed of double-woven stainless steel wire screen and associated polyethylene sample tubing is inserted through probe rods. The tubing is rotated to lock the implant into the anchor point. After the implant has been secured, the rods are removed, leaving the anchor point, implant, and tubing in place. The boring annulus is then backfilled, as appropriate. Backfill material around the screen interval may include glass beads or porous sand. Backfill material above the screen interval may include bentonite and/or quick-drying portland cement.

The implant and sample tubing are purged to remove one to three volumes of atmospheric air and allow the subsurface soil gas to enter the implant screen and sample tubing. Once the tubing has been satisfactorily purged to enable collection of a representative soil gas sample, a 1-liter to 6-liter pre-evacuated, SUMMA® canister is attached to the end of the tubing for sample collection. The sample is sent for laboratory analysis of VOCs by U.S. EPA Method TO-14 or TO-15.

Proprietary Information WASTE SAMPLING

1.0 PURPOSE

The objective of this SOP is to describe the equipment and procedures that can safely be used to collect waste samples. Hazardous wastes are regulated by the United States Environmental Protection Agency under 40 Code of Federal Regulations (CFR) Parts 260-265. As a consequence, many of the methods that are used to manage, store, treat, and dispose hazardous wastes and potential hazardous wastes are of concern to both the regulators and the regulated community.

Samples are often required of regulated or potentially regulated materials. While it is understood that each facility and waste stream may present its own unique sampling and analytical challenges, this section will list equipment and procedures that have been used to safely and successfully sample specific waste units.

1.1 Safety

Sampling of waste units should be assessed for potential hazards by both the project leader and the site safety officer (SSO). The SSO is responsible to enforce the site safety plan, and to ensure that procedures used during waste sampling are in accordance with Branch safety procedures and protocols found in Section 4.

Sampling equipment contaminated during waste sampling investigations should be cleaned with laboratory detergent and rinsed with tap water prior to returning the equipment from the field. Contaminated sampling equipment that is to be discarded must be properly disposed and should be specified in the site-specific study plan.

1.2 Quality Control Procedures

In some instances, special decontamination procedures will be necessary and should be developed on a case-by-case basis according to the specific material encountered. Any cleaning procedures and equipment repairs conducted in the field which deviate from the study plan, should be thoroughly documented in the logbooks. All air monitoring and field analytical/screening equipment should be checked and calibrated before being issued for field studies.

1.3 Collection of Auxiliary Information and Data

The collection of auxiliary information and data is particularly important when collecting waste samples. Any field analyses or field screening results should be recorded in a logbook. Sketches of waste units, sampling locations, containers, tanks and ancillary equipment, markings/labels, etc., should be fully documented in logbooks. Photographs are extremely useful for recording this information and may be used during waste sampling operations. A field log of the photographs taken should be maintained.

2.0 WASTE UNIT TYPES

Waste management units can be generally categorized into two types: open and closed. In practice, open units are larger than closed units. Open units include waste piles and surface impoundments; whereas, closed units include containers and tanks, as well as ancillary tank equipment. Besides containers and tanks, sumps may also be considered closed units because they are designed to collect the spillage of liquid wastes and are sometimes configured as a confined space.

Although both may pose hazards, units that are open to the environment are generally less hazardous than closed units. Sampling of closed units is considered a higher hazard risk because of the potential of exposure to toxic gases and flammable/explosive atmospheres. Because closed units prevent the dilution of the wastes by environmental influences, they are more likely to contain materials that have concentrated levels of hazardous constituents. While opening closed units for sampling purposes, investigators shall use Level B personnel protective equipment (PPE) air monitoring instruments to ensure that the working environment does not contain hazardous levels of flammable/explosive gasses or toxic vapors, and follow the appropriate safety requirements stipulated in the site-specific safety plan. Buried waste materials should be located and excavated with extreme caution. Once the buried waste is uncovered, the appropriate safety and sampling procedures utilized will depend on the type of waste unit.

2.1 Open Units

While open units may contain many types of wastes and come in a variety of shapes and sizes, they can be generally regarded as either waste piles or surface impoundments. Definitions of these two types of open units from 40 CFR Part 260.10 are:

- Waste pile any non-containerized accumulation of solid non-flowing hazardous waste that is
 used for treatment or storage and that is not a containment building.
- Surface impoundment -...a facility or part of a facility which is a natural topographic depression, man-made excavation, or diked area formed primarily of earthen materials (although it may be lined with man-made materials), which is designed to hold the accumulation of liquid wastes or wastes containing free liquids, and which is not an injection well. Examples of surface impoundments are holding, storage, settling and aeration pits, ponds, and lagoons.

One of the distinguishing features between waste piles and surface impoundments is the state of the waste. Waste piles typically contain solid or non-flowing materials whereas liquid wastes are usually contained in surface impoundments. The nature of the waste will also determine the mode of delivering the waste to the unit. Wastes are commonly pumped or gravity fed into impoundments while heavy equipment or trucks may be used to dump wastes in piles. Once the waste has been placed in an open unit, the state of the waste may be altered by environmental factors (e.g., temperature, precipitation, etc.).

Surface impoundments may contain several phases such as floating solids, liquid phase(s), and sludges. Waste piles are usually restricted to solids and semi-solids. All of the potential phases contained in a waste unit should be considered in developing the sample design to meet the study's objective.

2.2 Closed Units

There are a variety of designs, shapes, sizes, and functions of closed units. In addition to the challenges of the various designs and the safety requirements for sampling them, closed units are difficult to sample because they may contain liquid, solid, semi-solid/sludge, or any combination of phases. Based on the study's design, obtaining a cross-sectional profile of the closed unit to characterize the unit may be necessary. The following definitions are types of closed waste units described in 40 CFR Part 260.10:

 <u>Container</u> - any portable device in which a material is stored, transported, treated, disposed, or otherwise handled. Examples of containers are drums, overpacks, palls, totes, and roll offs.

- Tank a stationary device designed to contain an accumulation of hazardous waste which is constructed primarily of non-earthen materials which provide structural support. Portable tanks, tank trucks, and tank cars vary in size and may range from simple to extremely complex designs. Depending on the unit's design, these storage units may be considered tanks for sampling purposes even though they meet the definition of a container.
- Ancillary equipment (tank) any device including, but not limited to, such devices as piping, fittings, flanges, valves, and pumps that is used to distribute, meter, or control the flow of hazardous waste from its point of generation to a storage or treatment tank(s), between hazardous waste storage and treatment tanks to a point of disposal on site, or to a point of shipment for disposal off site.
- <u>Sump</u> any pit or reservoir that meets the definition of a tank and those troughs/trenches connected to it that serve to collect hazardous wastes.

Note: some outdoor sumps may be considered open units/surface impoundments.

Although any of the closed units may not be completely sealed and may be partially open to the environment, the unit needs to be treated as a closed unit for sampling purposes until a determination can be made. Once a closed unit is opened, a review of the proposed sampling procedures and level of protection can be performed to determined if the PPE is suitable for the site conditions.

Samples collected from different waste units should not be composited into one sample container without additional analytical and/or field screening data to determine if the materials are compatible and will not cause an inadvertent chemical reaction.

3.0 EQUIPMENT

Selecting appropriate equipment to sample wastes is a challenging task, due to the uncertainty of the physical characteristics and nature of the wastes. It may be difficult to separate, homogenize, and/or containerize a waste due to its physical characteristics (viscosity, particle size, etc.). In addition, the physical characteristics of a waste may change with temperature, humidity, or pressure. Waste streams may vary depending on how and when a waste was generated, how and where it was stored/disposed, and the conditions under which it was stored/disposed. Also, the physical location of the wastes or the unit configuration may prevent the use of conventional sampling equipment.

Given the uncertainties that a waste may present, select sampling equipment that will facilitate the collection of samples that will meet the study's objective, and that will not unintentionally bias the sample by excluding some of the sample population that is under consideration. However, due to the nature of some waste matrices or the physical constraints of some waste units, it may be necessary to collect samples knowing that a portion of the desired population was omitted due to limitations of the equipment. Any deviations from the study plan or difficulties encountered in the field concerning sample collection that may have an effect on the study's objective should be documented in a logbook, reviewed with the analytical data, and presented in the report.

3.1 Waste Sampling Equipment

Waste sampling equipment should be made of non-reactive materials that will neither add to nor alter the chemical or physical properties of the sampled material. Table 3.1 lists some conventional equipment for sampling waste units/phases and some potential limitations of the equipment. Another reference for selecting sampling equipment is the ASTM, Standard Guide for Selection of Sampling Equipment for Wastes and Contaminated Media Data Collection Activities, D 6232-98.

3.2 Ancillary Equipment for Waste Sampling

In addition to the equipment listed in Table 3.1 which provides the primary device used to collect various waste samples, ancillary equipment may be required during the sampling for safety and/or analytical reasons. Some examples of these types of equipment are glass mixing pans, particle size reducers, remote drum opening devices, and spark resistant tools. See Section 7.0 for particle size reduction procedures. Any influences that these types of ancillary equipment may have on the data should be evaluated and reported, as necessary.

Table 3.1
Sampling Equipment for Various Waste Units

Equipment	Waste Units/Phases	Limitations		
Scoop with	Impoundments, piles, containers,	Can be difficult to collect deeper phases in multiphase		
Bracket/Conduit	tanks/liquids, solids, sludges	wastes. Depth constraints.		
Spoon	impoundments, piles, containers/solids, sludges	Similar limitation as the scoop. Generally not effective in sampling liquids.		
Push Tube	piles, containers/cohesive solids, sludges	Should not be used to sample solids with dimensions >1/2 the diameter of the tube. Depth constraints.		
Auger	impoundments, piles, containers/ solids	Can be difficult to use in an impoundment or container, or for solidified wastes.		
Sediment Sampler	impoundments, piles, containers/ sludges	Should not be used to sample solids with dimensions >1/2 the diameter of the tube.		
Ponar Dredge	impoundments, solids/sludges	Must have means to position equipment to desired sampling location. Difficult to decon.		
COLIWASA or	impoundments, containers,	Not good with viscous wastes. Devices ≥7', require 2		
Drum Thief	tanks/liquids	samplers to use effectively.		
Dipstick™/	impoundments, containers,	Not recommended for tanks >11' deep. Devices ≥7',		
Mucksucker™	tanks/liquids, sludges	require 2 samplers to use effectively.		
Bacon Bomb	impoundments, tanks/liquids	Not good with viscous wastes.		
Bailer	Impoundments, tanks/liquids	Only if waste is homogenous. Not good with viscous wastes.		
Peristalitic Pump with Vacuum Jug Assembly	Impoundments, tanks/liquids	Cannot be used in flammable atmospheres. Not good with viscous wastes.		
Backhoe Bucket	piles/solids, sludges	May be difficult to access desired sampling location. Difficult to decon. Can lose volatiles.		
Split Spoon	piles/solids	Requires drill rig or direct-push equipment.		
Roto-bucket	piles, containers/solids	Physically breaks up sample. May release volatiles. Not for flammable atmospheres.		

4.0 WASTE SAMPLING PROCEDURES

4.1 Waste Piles

Waste piles vary in size, shape, composition, and compactness, and may vary in distribution of hazardous constituents and characteristics (strata). These variables will affect safety and access considerations. The number of samples, the type of sample(s), and the sample location(s) should be based on the study's objectives. Commonly used equipment to collect samples from waste piles are listed in Table 3.1. All equipment should be compatible with the waste and cleaned to prevent any cross contamination of the sample.

4.2 Surface Impoundments

Surface impoundments vary in size, shape, and waste content, and may vary in distribution of hazardous constituents and characteristics (strata). The number of samples, the type of sample(s), and the sample location(s) should be based on the study's objectives. Commonly used equipment to collect samples from surface impoundments are listed in Table 3.1. All equipment should be compatible with the waste and cleaned to prevent any cross contamination of the sample.

Because of the potential danger of sampling waste units suspected of containing elevated levels of hazardous constituents, personnel should never attempt to sample surface impoundments used to manage potentially hazardous wastes from a boat. All sampling should be conducted from the banks or piers of surface impoundments. Any exception must be approved by the appropriate site safety officer and/or the Occupational Health and Safety Designee

4.3 Drums

Drums are the most frequent type of containers sampled by field investigators for chemical analyses and/or physical testing. Caution should be exercised by the field investigators when sampling drums because of the potential presence of explosive/flammable gases and/or toxic vapors. Therefore, the following procedures should be used when collecting samples from drums of unknown material:

- 1. Visually inspect all drums that are being considered for sampling for the following:
 - pressurization (bulging/dimples);
 - crystals formed around the drum opening;
 - leaks, holes, stains;
 - labels, markings;
 - composition and type (steel/poly and open/bung);
 - condition, age, rust; and
 - sampling accessibility.

Drums showing evidence of pressurization and crystals should be furthered assessed to determine if remote drum opening is needed. If drums cannot be accessed for sampling, heavy equipment is usually necessary to stage drums for the sampling activities. Allow adequate time for the drum contents to stabilize after a drum is handled.

2. Identify each drum that will be opened (e.g., paint sticks, spray paint, cones, etc).

LEVEL "B" PROTECTION IS REQUIRED FOR THE FOLLOWING PROCEDURES.

- 3. Before opening, ground each metal drum that is not in direct contact with the earth using grounding wires, alligator clips, and a grounding rod or metal structure. If a metal drum is in an overpack drum, ground the metal drum.
- 4. Touch the drum opening equipment to the bung or lid and allow an electrical conductive path to form. Slowly remove the bung or drum ring and/or lid with spark resistant tools (brass/beryllium).
- 5. Screen drums for explosive gases and toxic vapors with air monitoring instruments as the bung or drum lid is removed. Depending on site conditions screen for one or more of the following:
 - radioactivity;
 - cyanide fumes;
 - halogen vapors;
 - pH; and/or
 - flash point (requires small volume of sample for testing).

Note the state, quantity, phases, and color of the drum contents. Record all relevant results, observations, and information in a logbook, Drum Data Form, or Drum Data Table. Figure 1 is an example of a Drum Data Form. Review the screening results with any pre-existing data to determine which drums will be sampled.

- 6. Select the appropriate sampling equipment based on the state of the material and the type of container. Sampling equipment should be made of non-reactive materials that will meet the study's objective(s).
- 7. Place oil wipe (as necessary), sampling equipment, and sample containers near drum(s) to be sampled.

AIR MONITORING FOR TOXIC VAPORS AND EXPLOSIVE GASES AND OXYGEN DEFICIENT ATMOSPHERES SHOULD BE CONDUCTED DURING DRUM SAMPLING.

<u>Liquids</u> - Slowly lower the COLIWASA or drum thief to the bottom of the container. Close the COLIWASA with the inner rod or create a vacuum with the sampler's gloved thumb on the end of the thief and slowly remove the sampling device from the drum. Release the sample from the device into the sample container. Repeat the procedure until a sufficient sample volume is obtained.

<u>Solids/Semi-Solids</u> - Use a push tube, bucket auger, or screw auger or if conditions permit a pneumatic hammer/drill to obtain the sample. Carefully use a clean stainless steel spoon to place the sample into container(s) for analyses.

8. Close the drums when sampling is complete. Segregate contaminated sampling equipment and investigative derived wastes (IDW) containing incompatible materials as determined by the drum screening procedure (Step #5). At a minimum, clean the contaminated equipment with laboratory detergent and rinse with tap water prior to returning the equipment. IDW should be managed in accordance with state and federal waste regulations.

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Proprietary Information

Figure 1 Drum Data Form

Date:			Page:
Sample collected: Y / N			
City:	State:	· · · · · · · · · · · · · · · · · · ·	
Site Drum ID #:	Other Drur	m ID #:	
Drum Observations:			-
1) Overpack: Y / N	Metal / Pla	stic / Other:	W L
Size: 85 / 55 /			
2) Drum: Metal / Plastic / Other: _			
Size: 85 / 55 /			
Condition: Good / Fair / Po	oor		
Markings/Labels:			
	Manual Control of the		
3) Drum Opening Team:		11_12314_12	
4) Estimated Volume: Full / ¾ / ½	11/4 / Empty		
5) Physical Appearance of Drum C	ontents:		
	N.P. and a Marie	I (8 # - 1 / 1 ft - 6	
Color:	- · · · · · · · · · · · · · · · · · · ·		
Phased: Y / N ; Descriptio			
Other:			Name to the second seco
6) Air monitoring results:			
PIDpr	m Explos	%O ₂	_%LEL
FIDp		Yes	_No
CNpr			saa
	rem		-
7) Flash Point Sample Collected:	Yes / No		
Flash Results at 140 F:	Yes / No		
Hot Wire Test for Halogen:	Pos / Neg		
HOLVERO TOSTION HAIOGON.	1 03 / 1409		
8) Sample Collected:	Yes / No	Time:	
Collector(s):		· -	

4.4 Tanks

Sampling tanks is considered hazardous due to the potential for them to contain large volumes of hazardous materials and, therefore, appropriate safety protocols must be followed. Unlike drums, tanks may be compartmentalized or have complex designs. Review preliminary information about the tank's contents and configuration prior to the sampling operation to ensure the safety of sampling personnel and that the study's objectives can be achieved.

In addition to having discharge valves near the bottom of tanks and bulk storage units, most tanks have hatches at the top. Collect samples from the top hatch, if possible, due to the potential for the tank's contents to be stratified. When sampling from the discharge valve, note that a stuck or broken valve could cause an uncontrolled release. Investigators should not utilize valves on tanks or bulk storage devices unless operated by the owner/operator of the facility or a containment plan is in place if the valve sticks or breaks. If the investigator must sample from a tank discharge valve, the valving arrangement of the particular tank must be understood to ensure the compartment(s) of interest is sampled.

Because of the many different types of designs and materials that may be encountered, only general sampling procedures that outline sampling a tank from the top hatch are listed below:

- 1. All relevant information concerning the tank such as the type of tank, the tank capacity, markings, condition, and suspected contents should be documented in a logbook.
- 2. The samplers should inspect the ladder, stairs, and catwalk used to access the top hatch to ensure that they will support the samplers and their equipment.

LEVEL "B" PROTECTION IS REQUIRED FOR THE FOLLOWING PROCEDURES.

- 3. Before opening, ground each metal tank using grounding wires, alligator clips, and a grounding rod or metal structure.
- 4. Any vents or pressure release valves should be slowly opened to allow the unit to vent to atmospheric pressure. Air monitoring for explosive/flammable gases and toxic vapors should be conducted during the venting with the results recorded in a logbook. If dangerous concentrations of gases evolve from the vent or the pressure is too great, leave the area immediately.
- 5. Touch tank opening equipment to the bolts in the hatch lid and allow electrical conductive path to form. Slowly remove bolts and/or hatch with spark resistant tools (brass/beryllium). If a pressure build up is encountered or detected, cease opening activities and leave the area.
- 6. Screen tanks for explosive/flammable gases and toxic vapors with air monitoring instruments. Depending on the study objectives and site conditions, conduct characteristic screening (e.g., pH, halogen, etc.) as desired. Collect a small volume of samples for flash point testing, if warranted. Note the state, quantity, number of phases, and color of the tank contents. Record all relevant results, observations, and information in a logbook. Compare the screening results with any preexisting data to determine if the tank should be sampled.

- 7. Select the appropriate sampling equipment based on the state of the material and the type of tank. Sampling equipment should be constructed of non-reactive materials that will meet the study's objective(s).
- 8. Place oil wipe (as necessary), sampling equipment, and sample containers near tanks(s) to be sampled.

AIR MONITORING FOR TOXIC VAPORS, EXPLOSIVE GASES, AND OXYGEN DEFICIENT ATMOSPHERES SHOULD BE CONTINUOUS DURING TANK SAMPLING.

<u>Liquids</u> - Slowly lower the bailer, bacon bomb, Dipstick[™], COLIWASA, or Teflon® tubing to the desired sampling depth. (NOTE: In work areas where explosive/flammable atmospheres could occur, peristaltic pumps powered by 12 V. batteries should not be used.) Close the sampling device or create a vacuum and slowly remove the sampling device from the tank. Release the sample from the device into the sample container. Repeat the procedure until a sufficient sample volume is obtained.

Solids/Semi-Solids - Use a push tube, bucket auger, screw auger, Mucksucker™, or if conditions permit, a pneumatic hammer/drill to obtain the sample. Carefully extrude the sample from the sampling device or use a clean stainless steel spoon to place the sample into containers for analyses.

9. Close the tank when sampling is complete. Segregate contaminated sampling equipment and investigative derived wastes (IDW) containing incompatible materials as determined by the screening procedure (Step #6). At a minimum, clean contaminated equipment with laboratory detergent and rinse with tap water prior to returning it from the field. IDW should be managed according to state and federal waste regulations.

5.0 MISCELLANEOUS CONTAMINATED MATERIALS

Sampling may be required of materials or equipment (e.g., documents, building materials, equipment, etc.) to determine whether or not various surfaces are contaminated by hazardous constituents, or to evaluate the effectiveness of decontamination procedures.

Wipe or swab samples may be taken on non-absorbent, smooth surfaces such as metal, glass, plastic, etc. The wipe materials must be compatible with the solvent used and the analyses to be performed, and should not come apart during use. The wipes are saturated with a solvent; methylene chloride, hexane, isopropanol, or analyte free water depending on the parameters to be analyzed. The laboratory performing the analyses can provide the appropriate solvent. Wipe samples should not be collected for volatile organic compounds (VOCs) analysis. Sampling personnel should be aware of hazards associated with the selected solvent and should take appropriate precautions to prevent any skin contact or inhalation of these solvents. All surfaces and areas selected for sampling should be based on the study's objectives. Typically, 10-cm-by-10-cm templates are prepared from aluminum foil which are secured to the surface of interest. The prepared (saturated with solvent) wipe(s) is removed from its container with tongs or gloves, and used to wipe the entire area with firm strokes using only one side of the wipe. The goal is to systematically wipe the whole area. The wipe is then folded with the sample side

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inward and placed into the sample container. This procedure is repeated until the area is free of visible contamination or no more wipes remain. Keep the sample container tightly sealed to prevent evaporation of the solvent. Samplers must also take care to not touch the used side of the wipe. (Note: if gloves are used to collect the wipe samples, control samples should be collected to determine if the gloves could potentially contribute constituents to the parameters of interest.)

For items with porous surfaces such as insulation, wood, etc., actual samples of the materials are required. Therefore, take caution during the collection and/or analyses of the sample so that evidentiary material is not destroyed. Use scissors or other particle reduction device that have been decontaminated. Place the shredded, homogenized material in sample containers.

6.0 WASTE SAMPLING HANDLING PROCEDURES

When collecting samples of concentrated wastes for laboratory analyses, field personnel are required to screen the waste materials to ensure safe handling and transportation of the samples. Safety procedures, and sampling and screening methods used to collect the samples must comply with those procedures/methods described in this SOP. Note that waste samples should not be preserved because of the potential for an inadvertent chemical reaction with the preservative. Additionally, concentrated waste samples are not required to be cooled to 4°C.

After samples have been collected and containerized, the outside of the sample containers should be cleaned with water, paper towels and/or oil wipes to remove any spilled material from the exterior of the container. Each sample container should be tagged and sealed, placed in a plastic bag, and the bag securely closed. Samples collected from materials that did not demonstrate any hazardous characteristics during the screening process may be placed in coolers and handled as non-hazardous samples.

Field investigators use the knowledge gained of site practices and processes, labels and marking on waste containers, field screening results, and personal observations made during their investigation to determine the hazard potential of a sample. Place samples considered to be hazardous by the field investigators in secondary containment for transport to the SESD laboratory and for subsequent handling upon arrival. Place the tagged, sealed, and bagged samples in a 6-quart plastic pail, packed with vermiculite, and sealed with a tight-fitting lid. Mark the project number for the sampling investigation and the specific sample station number on the secondary container in indelible ink. Affix a standard SESD Hazard Communication Label to the side of the secondary container. Indicate the appropriate hazard(s) for the sample (Health, Flammability, and/or Reactivity) with an "X." Additionally, place an "X" in the "Protective Equipment" section.

Secure all secondary containing pails in the vehicles while transporting the samples from the field to the laboratory for analyses. In addition, each pail should indicate when protective equipment is recommended to handle the actual waste/sample material.

7.0 PARTICLE SIZE REDUCTION

Particle size reduction of waste samples is periodically required in order to complete an analytical scan or the Toxicity Characteristic Leaching Procedure (TCLP) test. Samples that may require particle size reduction include slags, bricks, glass/mirror cullet, wire, etc. Method 1311 (TCLP) states "Particle size

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reduction is required, unless the solid has a surface area per gram of material equal to or greater than 3.1 cm², or is smaller than 1 cm in its narrowest dimension (i.e., capable of passing through a 9.5-mm (0.375-inch) standard sieve). If the surface area is smaller or the particle size larger than described above, prepare the solid portion of the waste for extraction by crushing, cutting, or grinding the waste to a surface area or particle size as described above" (55 FR 26990). The method also states that the surface criteria are meant for filamentous (paper, cloth, etc.) waste materials, and that "Actual measurement of the surface area is not required, nor is it recommended." Also, the loss of VOCs could be significant during particle size reduction.

Waste samples that require particle size reduction are often too large for standard sample containers. If this is the case, secure the sample in a clean plastic bag and process using normal chain-of-custody procedures. Note that the tags that are required for the various containers should be prepared in the field and either inserted into or attached to the sample bag. Seal the bag with a custody seal.

The following procedure may be used for crushing and/or grinding a solid sample:

- 1. Remove the entire sample, including any fines that are contained in the plastic bag, and place them on the standard cleaned stainless steel pan.
- 2. Using a clean hammer, carefully crush or grind the solid material (safety glasses are required), attempting to minimize the loss of any material from the pan. Some materials may require vigorous striking by the hammer, followed by crushing or grinding. The material may be subject to crushing/grinding rather than striking.
- 3. Continue crushing/grinding the solid material until the sample size approximates 0.375 inch.

 Attempt to minimize the creation of fines that are significantly smaller than 0.375 inch in diameter.
- 4. Pass the material through a clean 0.375-inch sieve into a glass pan.
- Continue this process until sufficient sample is obtained. Thoroughly mix the sample as
 described in Section 5.13.8 of this SOP. Transfer the contents of the glass pan into the
 appropriate containers.
- 6. Attach the previously prepared tags and submit for analyses.

8.0 REFERENCES

- 1. Title 40 Code of Federal Regulations, Parts 260-265, US-EPA, July 1, 2000.
- 2. ASTM, Standard Guide for Selection of Sampling Equipment for Wastes and Contaminated Media Data collection Activities, D 6232-98, 1998.
- 3. ASTM, Standard Guide for Sampling Strategies for Heterogeneous Wastes, D 5956-96, 1996.

- 4. Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW-846), Third Edition, Draft Update IVB, US-EPA, Office of Solid Waste and Emergency Response, Washington, D.C., November, 2000.
- 5. Compendium of ERT Waste Sampling Procedures, US-EPA, EPA/540/P-91/008 (OSWER Directive 9360.4-07), January 1991.
- 6. Characterization of Hazardous Waste Sites A Methods Manual: Volume 1 -Site Investigations, US EPA, EMSL, Las Vegas, EPA-600/4-84-075, April 1985.
- 7. Characterization of Hazardous Waste Sites A Methods Manual: Volume II --Available Sampling Methods, 2nd Edition, US-EPA, EMSL, Las Vegas, EPA 600/4-84-076, December 1984.
- 8. Federal Register, Volume: 55, Issues 26, Page: 26990, Friday, June 29, 1990.

PACKING AND SHIPPING OF SAMPLES

1.0 PURPOSE AND APPLICABILITY

This Standard Operating Procedure (SOP) details the procedures associated with the packaging and shipping of groundwater, surface water, soil, and waste samples. The purpose of this SOP is to identify general procedures to minimize sample loss through breakage, spillage, or leakage.

Based on United States Environmental Protection Agency (U.S.EPA) regulations 40 Code of Federal Regulations (CFR) Sec. 261.4(d), samples collected for the sole purpose of testing are exempt from Resource Conservation and Recovery Act regulations when one of the following conditions are applicable:

- Samples are being transported to a laboratory for analysis;
- Samples are being transported to the collector from the laboratory after analysis; or
- Samples are being stored (i) by the collector prior to shipment for analysis, (ii) by the analytical laboratory prior to analysis, or (iii) by the analytical laboratory after testing but prior to return of sample to the collector or pending the conclusion of a court case.

Samples collected during field investigations or in response to a hazardous materials incident must be classified prior to shipment, as either environmental or hazardous materials samples. In general, environmental samples include drinking water, most groundwater and ambient surface water, soil, sediment, treated municipal and industrial wastewater effluent, biological specimens, or any samples not expected to be contaminated with high levels of hazardous materials.

Samples collected from process wastewater streams, drums, bulk storage tanks, soil, sediment, or water samples from areas suspected of being highly contaminated may require shipment as dangerous goods. Regulations for packing, marking, labeling, and shipping of dangerous goods by air transport are promulgated by the International Air Transport Authority (IATA).

2.0 RESPONSIBILITIES

The Field Team Leader or his/her designee is responsible for ensuring that the proper sample packaging and shipping procedures are implemented.

3.0 REQUIRED MATERIALS

- Shipping containers, e.g., cardboard boxes, ice chests;
- Shipping labels and chain-of-custody forms;
- Packing tape;
- Chain-of-custody tape or tags;
- Packing material, e.g., styrofoam, vermiculite;
- Ice, cold packs, or other suitable cooling agents; and
- Marking pens.

4.0 SAFETY PRECAUTIONS

No specific safety precautions are necessary; however, all personnel must recognize and adhere to health and safety policies governing the handling of potentially hazardous materials and when lifting sample packages.

5.0 PROCEDURE

5.1 Shipment of Environmental Laboratory Samples

Guidance for the shipment of environmental laboratory samples is provided in a memorandum dated March 6, 1981, subject "Final National Guidance Package for Compliance with Department of Transportation Regulations in the Shipment of Laboratory Samples" (3). By this memorandum, the shipment of the following <u>unpreserved</u> samples is not regulated:

- Drinking water;
- Treated effluent;
- Biological specimens;
- Sediment:
- Water treatment plant sludge; and
- POTW sludge.

In addition, the shipment of the following preserved samples is not regulated, provided the amount of preservative used does not exceed the amounts found in 40 CFR 136.3(4). The shipper (individual signing the air waybill) is responsible to ensure that proper amounts of preservative are used:

- Drinking water;
- Ambient water:
- Treated effluent:
- Biological specimens;
- Sediment;
- Wastewater treatment plant sludge; and
- Water treatment plant sludge.

Samples determined by the project leader to be in these categories are to be shipped using the following protocol, developed jointly between the U.S. EPA, Occupational Safety and Health Administration, and Department of Transportation (DOT). This procedure is documented in the "Final National Guidance Package for Compliance with Department of Transportation Regulations in the Shipment of Environmental Laboratory Samples."

Untreated wastewater and sludge from POTWs are considered to be "diagnostic specimens" (not environmental laboratory samples). However, because they are not considered to be etiologic agents (infectious), they are not restricted and may be shipped using the procedures outlined below.

Environmental samples should be packed prior to shipment by air using the following procedures:

- 1. Allow sufficient headspace (ullage) in all bottles (except volatile organic compounds containers with a septum seal) to compensate for any pressure and temperature changes (approximately 10 percent of the volume of the container).
- 2. Be sure the lids on all bottles are tight (will not leak).
- 3. Place bottles in separate and appropriately sized polyethylene bags and seal the bags with tape (preferably plastic electrical tape), or separate each sample container with plastic-bubble wrap matting or other suitable material.
- 4. Select a sturdy cooler in good repair. Place plastic-bubble wrap matting or other suitable material on bottom and in corners.
- 5. Place sample containers upright in ice chest and, if necessary, complete chain-of-custody form(s) for samples contained in each packaged cooler.
- 6. Place suitable packaging material throughout the voids in the ice chest to restrict sample container movement.
- 7. Secure and tape the drain plug with fiber or duct tape.
- 8. Place "blue ice" or ice that has been "double bagged" in heavy-duty polyethylene bags and properly sealed on top of and/or between the samples. The purpose of this is to reduce free water in the ice chests. Fill all remaining space between the bottles with vermiculite or other suitable material to completely fill the ice chest.
- 9. Place the chain-of-custody record into a plastic bag, and tape the bag to the inner side of the cooler lid.
- 10. Close the cooler and securely tape (preferably with fiber tape) the top of the cooler shut. Chain-of-custody seals should be affixed to the top and sides of the cooler within the securing tape so that the cooler cannot be opened without breaking the seal.
- 11. Shipping containers must be marked "THIS END UP," and arrow labels which indicate the proper upward position of the container should be affixed to the container. A label containing the name and address of the shipper should be placed on the outside of the container. Labels used in the shipment of hazardous materials (e.g., Cargo Only Aircraft, Flammable Solids, etc.) are not permitted to be on the outside of containers used to transport environmental samples.
- 12. Use air-express overnight delivery service, if immediate sample delivery to the laboratory is required and samples cannot be hand delivered to the laboratory.

5.2 Shipment of Dangerous Goods

The Field Team Leader is responsible for determining if samples collected during a specific field investigation meet the definitions for dangerous goods. If a sample is collected of a material that is listed in the Dangerous Goods List, Section 4.2, IATA, then that sample must be identified, packaged, marked, labeled, and shipped according to the instructions given for that material. If the composition of the collected sample(s) is unknown, and the project leader knows or suspects that it is a regulated material (dangerous goods), the sample may not be offered for air transport. If the composition and properties of the waste sample or highly contaminated soil, sediment, or water sample are unknown, or only partially known, the sample may not be offered for air transport.

In addition, the shipment of pre-preserved sample containers or bottles of preservatives (e.g., NaOH pellets, HCL, etc.) which are designated as dangerous goods by IATA is regulated.

6.0 DOCUMENTATION

Completed chain-of-custody records should contain shipping information, including the carrier airbill number. Obtain copies of shipment records from all handlers/couriers of sample packages. This documentation will be maintained in the project file.

7.0 REFERENCES

- IATA, 1995. Dangerous Goods Regulations, International Air Transport Authority (IATA). 31st Edition, Effective January 1, 1995.
- U.S. EPA, 1984. Characterization of Hazardous Waste Sites, a Methods Manual. Volume 2. 2nd ed. EPA-600/4-84-076.
- U.S. EPA, 1981. "Final Regulation Package for Compliance with DOT Regulations in the Shipment of Environmental Laboratory Samples." Memo from David Weitzman, Work Group Chairman, Office of Occupational Health and Safety (PM-273), U.S. EPA, April 13, 1981.
- 40 CFR 136.3. July 1, 1994. Table 11, Footnote 3.

SAMPLE CHAIN-OF-CUSTODY

1.0 PURPOSE AND APPLICABILITY

This Standard Operating Procedure (SOP) details the specific procedures to be employed to document possession/custody of samples, (i.e., groundwater, surface water, stormwater runoff, plant discharge water, soils, etc.) from the time of collection through arrival at the receiving laboratory for analysis. At this point, internal laboratory records should document sample custody until its final disposition. This SOP also discusses sample identification and the use of chain-of-custody forms.

Chain-of-custody procedures are comprised of the following elements: 1) maintaining sample custody and 2) documentation of samples for evidence. To document chain of- custody, an accurate record must be maintained to trace the possession of each sample from the moment of collection to its introduction into evidence.

A sample or other physical evidence is in custody if:

- it is in the actual possession of an investigator;
- it is in the view of an investigator, after being in their physical possession;
- it was in the physical possession of an investigator and then they secured it to prevent tampering;
 and/or
- it is placed in a designated secure area.

2.0 RESPONSIBILITIES

The Site Coordinator (Field Team Leader) or his/her designee is responsible for ensuring that sample labeling is completed in accordance with this SOP and that chain-of-custody forms are completed for sample shipments. All individuals relinquishing and receiving samples shall sign, date, and record the time on the chain-of-custody forms.

3.0 REQUIRED MATERIALS

- Chain-of-custody, and
- Field logbook.

4.0 SAFETY PRECAUTIONS

No specific safety precautions are needed for this procedure. All sample jars should be handled using gloves.

5.0 PROCEDURE

5.1 Sample Identification

A label will be affixed to each sample container. Each sample will be identified with a label which is waterproof. The label shall contain the following information:

- 1. Site name.
- 2. Sample designation, as indicated in site-specific field sampling and analysis plan or work plan.
- 3. Date six digit number; e.g., 06/12/05.
- 4. Time four digit number; e.g., 0954 for 9:54 a.m.; 1629 for 4:29 p.m.
- 5. Sample analyses to be completed.
- 6. Preservatives.

5.2 Chain-of-Custody Forms

Once the samples have been properly labeled, they will be ready for shipment to the receiving laboratory. Boxes, coolers, etc. containing samples will be accomplished by a chain-of-custody form. The following procedures shall then be used:

- 1. The Field Team Leader or his/her designee shall complete a chain-of-custody form for each packages lot of samples (e.g., box, cooler). The following information should be recorded on the form:
 - Sample site/location;
 - Sampling date and time;
 - Sampler's name;
 - Sample identification;
 - Sample description, e.g., surface water, solid waste;
 - Analyses to be performed on sample(s);
 - Total number of sample containers per sample location;
 - Number of sample containers per each analysis; and
 - Name(s) and signature(s) of personnel collecting sample(s).
- 2. The person transporting samples to the shipment courier (e.g., airline, Federal Express, bus line) shall indicate on the chain-of-custody form (remarks box) the courier's name, date, and time. Also note in the remarks box if split samples are being shipped and to what laboratory/organization. Have the courier sign the form, if possible.
- 3. Forward the original chain-of-custody form with each packaged lot of samples. The Field Team Leader shall retain a copy of each form and forward them to the Project Manager or project scientist/engineer.

- 4. Upon receipt of the samples by the laboratory, the original chain-of-custody form should be signed and dated by the laboratory person assigned to log-in samples. In addition, the receiving laboratory should inspect each sample, particularly tape sealing of the sample, and indicate condition on the form. The receiving laboratory should retain a copy of each chain-of-custody form along with the shipper's airbill.
- 5. Internal laboratory documentation should take control of the sample once it is logged in by the receiving laboratory.

6.0 QUALITY CONTROL

Properly executed and maintained chain-of-custody records are needed to document the validity of the sample and its analytical results, and to ensure that the sample has not been tampered with.

7.0 DOCUMENTATION

The original chain-of-custody form must be shipped with the samples and retained by the receiving laboratory. The Field Team Leader will retain a copy of the form and provide the project scientist/engineer with a copy for central filing. The field logbook should also be used to record similar information concerning chain-of-custody and other quality assurance information.

Proprietary Information STANDARD FIELD CLEANING

1.0 PURPOSE

Cleaning procedures in this operating procedure are intended for use by field personnel for cleaning sampling and other equipment in the field to remove contaminants of concern from sampling, drilling, and other field equipment to concentrations that do not impact study objectives. Emergency field sample container cleaning procedures are also included; however, they should not be used unless absolutely necessary.

Sampling and field equipment cleaned in accordance with these procedures must meet the minimum requirements for Data Quality Objectives (DQO) definitive data collection. Deviations from these procedures should be documented in the approved study plan, field records, and investigative reports.

2.0 MATERIALS AND METHODS

These are the materials, methods, and procedures to be used when cleaning sampling and other equipment in the field.

2.1 Materials

Specifications for standard cleaning materials referred to in this appendix are as follows:

- <u>Soap</u> shall be a standard brand of phosphate-free laboratory detergent such as Liquinox®. Use of other detergent must be justified and documented in the field logbooks and inspection or investigative reports.
- <u>Solvent</u> shall be pesticide-grade isopropanol. Use of a solvent other than pesticide-grade
 isopropanol for equipment cleaning purposes must be justified in the study plan. Otherwise, its
 use must be documented in field logbooks and inspection or investigation reports.
- <u>Tap water</u> may be used from any municipal water treatment system. Use of an untreated potable water supply is not an acceptable substitute for tap water.
- Analyte free water (deionized water) is tap water that has been treated by passing through a standard deionizing resin column. At a minimum, the finished water should contain no detectable heavy metals or other inorganic compounds (i.e., at or above analytical detection limits) as defined by a standard inductively coupled Argon Plasma Spectrophotometer (ICP) (or equivalent) scan. Analyte free water obtained by other methods is acceptable, as long as it meets the above analytical criteria. Distilled water meets this criterion.
- Organic/analyte free water is defined as tap water that has been treated with activated carbon
 and deionizing units. A portable system to produce organic/analyte free water under field
 conditions is available. At a minimum, the finished water must meet the analytical criteria of
 analyte free water and should contain no detectable pesticides, herbicides, or extractable organic
 compounds, and no volatile organic compounds above minimum detectable levels, as determined
 by the Region 4 laboratory for a given set of analyses. Organic/analyte free water obtained by
 other methods is acceptable, as long as it meets the above analytical criteria. Distilled water
 meets this criterion.

Other solvents may be substituted for a particular purpose if required. For example, removal of
concentrated waste materials may require the use of either pesticide-grade hexane or petroleum
ether. After the waste material is removed, the equipment must be subjected to the standard
cleaning procedure. Because these solvents are not miscible with water, the equipment must be
completely dry prior to use.

Solvents, laboratory detergent, and rinse waters used to clean equipment shall not be reused during field decontamination.

2.2 Handling and Containers for Cleaning Solutions

Improperly handled cleaning solutions may easily become contaminated. Storage and application containers must be constructed of the proper materials to ensure their integrity. Following are acceptable materials used for containing the specified cleaning solutions:

- <u>Soap</u> must be kept in clean plastic, metal, or glass containers until used. The soap should be poured directly from the container during use.
- <u>Solvent</u> must be stored in the unopened original containers until used. They may be applied using the low-pressure nitrogen system fitted with a Teflon® nozzle, or using Teflon® squeeze bottles.
- <u>Tap water</u> may be kept in clean tanks, hand pressure sprayers, squeeze bottles, or applied directly from a hose.
- Organic/analyte free water must be stored in clean glass, stainless steel, or plastic containers that can be closed prior to use. It can be applied from plastic squeeze bottles.

Note: Hand pump sprayers generally are not acceptable storage or application containers for the above materials (with the exception of tap water). This also applies to stainless steel sprayers. All hand sprayers have internal oil coated gaskets and black rubber seals that may contaminate the solutions.

2.3 Equipment Contaminated with Concentrated Wastes

Equipment used to collect samples of hazardous materials or toxic wastes or materials be field cleaned before returning from the study. At a minimum, this should consist of washing with soap and rinsing with tap water. More stringent procedures may be required at the discretion of the field investigators.

2.4 Safety Procedures for Field Cleaning Operations

Some of the materials used to implement the cleaning procedures outlined in this appendix can be harmful if used improperly. Caution should be exercised by all field investigators and all applicable safety procedures should be followed. At a minimum, the following precautions should be taken in the field during these cleaning operations:

- Safety glasses with splash shields or goggles, and latex gloves will be worn during all cleaning operations.
- Solvent rinsing operations will be conducted in the open (never in a closed room).

 No eating, smoking, drinking, chewing, or any hand to mouth contact should be permitted during cleaning operations.

2.5 Handling of Cleaned Equipment

After field cleaning, equipment should be handled only by personnel wearing clean gloves to prevent recontamination. In addition, the equipment should be moved away (preferably upwind) from the cleaning area to prevent recontamination. If the equipment is not immediately reused, cover equipment with plastic sheeting or wrap in aluminum foil to prevent recontamination. The area where the equipment is kept prior to re-use must be free of contaminants.

3.0 FIELD EQUIPMENT CLEANING PROCEDURES

Sufficient clean equipment should be transported to the field so that an entire study can be conducted without the need for field cleaning. However, this is not possible for some specialized items such as portable power augers, well drilling rigs, soil coring rigs, and other large pieces of field equipment.

In addition, particularly during large-scale studies, it is not practical or possible to transport all of the precleaned field equipment required into the field. In these instances, sufficient pre-cleaned equipment should be transported to the field to perform at least one days work. The following procedures are to be utilized when equipment must be cleaned in the field.

3.1 Specifications for Decontamination Pads

Decontamination pads constructed for field cleaning of sampling and drilling equipment should meet the following minimum specifications:

- The pad should be constructed in an area known or believed to be free of surface contamination.
- The pad should not leak excessively.
- If possible, the pad should be constructed on a level paved surface and should facilitate the removal of wastewater. This may be accomplished by either constructing the pad with one corner lower than the rest, or by creating a sump or pit in one corner or along one side. Any sump or pit should also be lined.
- Sawhorses or racks constructed to hold equipment while being cleaned should be high enough above ground to prevent equipment from being splashed.
- Water should be removed from the decontamination pad frequently.
- A temporary pad should be lined with a water impermeable material with no seams within the pad. This material should be either easily replaced (disposable) or repairable.

At the completion of site activities, the decontamination pad should be deactivated. The pit or sump should be backfilled with the appropriate material designated by the site project leader, but only after all waste/rinse water has been pumped into containers for disposal. No solvent rinsates will be placed in the pit. Solvent rinsates should be collected in separate containers for proper disposal. See Section 5.15 of this SOP for proper handling and disposal of these materials. If the decontamination pad has leaked excessívely, soil sampling may be required.

3.2 General Sampling Equipment

For routine operations involving analyses such as oxygen demand, nutrients, certain inorganics, sulfide, flow measurements, etc., water quality sampling equipment such as Kemmerers, buckets, dissolved oxygen dunkers, dredges, etc., may be cleaned with the sample or analyte-free water between sampling locations. A brush may be used to remove deposits of material or sediment, if necessary. If analyte-free water is unavailable, the samplers should be flushed at the next sampling location with the substance (water) to be sampled, before the sample is collected. Flow measuring equipment such as weirs, staff gages, velocity meters, and other stream gaging equipment may be cleaned with tap water between measuring locations, if necessary.

The previously described procedures are not to be used for cleaning field equipment to be used for the collection of samples undergoing trace organic or inorganic constituent analyses.

3.3 Trace Organic and Inorganic Compound Sampling Equipment

The following procedures are to be used for all sampling equipment used to collect routine samples undergoing trace organic or inorganic constituent analyses:

- Clean with tap water and soap using a brush, if necessary, to remove particulate matter and surface films. Equipment may be steam cleaned (soap and high-pressure hot water) as an alternative to brushing. Sampling equipment that is steam cleaned should be placed on racks or saw horses at least 2 feet above the floor of the decontamination pad. PVC or plastic items should not be steam cleaned.
- 2. Rinse thoroughly with tap water.
- 3. Rinse thoroughly with analyte free water.
- 4. Rinse thoroughly with solvent. Do not solvent rinse PVC or plastic items.
- 5. Rinse thoroughly with organic/analyte free water. If organic/analyte free water is not available, equipment should be allowed to completely dry. Do not apply a final rinse with analyte water. Organic/analyte free water can be generated onsite utilizing the portable system.
- 6. Remove the equipment from the decontamination area and cover with plastic. Equipment stored overnight should be wrapped in aluminum foil and covered with clean unused plastic.

3.4 Well Sounders or Tapes

- 1. Wash with soap and tap water.
- 2. Rinse with tap water.
- 3. Rinse with analyte free water.

3.5 Submersible Pump Cleaning Procedure

CAUTION - During cleaning, always disconnect the pump from the generator.

A submersible pump should be cleaned prior to use and between each monitoring well. The following procedure is required:

- 1. Using a brush, scrub the exterior of the contaminated hose and pump with soap and tap water.
- 2. Rinse the soap from the outside of the pump and hose with tap water.
- 3. Rinse the tap water residue from the outside of pump and hose with analyte-free water.
- 4. Place the pump and hose in a clean plastic bag.

3.6 Redi-Flo2® Pump

The Redi-Flo2® pump should be cleaned prior to use and between each monitoring well. The following procedure is required:

CAUTION - Make sure the pump is not plugged in.

- 1. Using a brush, scrub the exterior of the pump, electrical cord, and garden hose with soap and tap water. Do not wet the electrical plug.
- 2. Rinse with tap water.
- 3. Rinse with analyte free water.
- 4. Place the equipment in a clean plastic bag.

To clean the Redi-Flo2® ball check valve:

- 1. Completely dismantle ball check valve. Check for wear and/or corrosion and replace, as needed.
- 2. Using a brush, scrub all components with soap and tap water.
- 3. Rinse with analyte free water.
- 4. Reassemble and reattach the ball check valve to the Redi-Flo2® pump head.

4.0 DOWNHOLE DRILLING EQUIPMENT

These procedures are to be used for drilling activities involving the collection of soil samples for trace organic and inorganic constituent analyses, and for the construction of monitoring wells to be used for the collection of groundwater samples for trace organic and inorganic constituent analyses.

4.1 Introduction

Cleaning and decontamination of all equipment should occur at a designated area (decontamination pad) on the site. The decontamination pad should meet the specifications of Section 3.1. Tap water (potable) brought on the site for drilling and cleaning purposes should be contained in a pre-cleaned tank. A steam cleaner and/or high-pressure hot water washer capable of generating a pressure of at least 2,500 PSI and producing hot water and/or steam (200°F plus), with a soap compartment, should be obtained.

4.2 Preliminary Cleaning and Inspection

The drill rig should be clean of any contaminants that may have been transported from another hazardous waste site to minimize the potential for cross-contamination. Further, the drill rig itself should not serve as a source of contaminants. In addition, associated drilling and decontamination equipment, well construction materials, and equipment handling procedures should meet these minimum specified criteria:

- All downhole augering, drilling, and sampling equipment should be sandblasted before use if
 painted, and/or there is a buildup of rust, hard or caked matter, etc., that cannot be removed by
 steam cleaning (soap and high-pressure hot water), or wire brushing. Sandblasting should be
 performed prior to arrival on site, or well away from the decontamination pad and areas to be
 sampled.
- Any portion of the drill rig, backhoe, etc., that is over the borehole (kelly bar or mast, backhoe buckets, drilling platform, hoist or chain pulldowns, spindles, cathead, etc.) should be steam cleaned (soap and high-pressure hot water) and wire brushed (as needed) to remove all rust, soil, and other material which may have come from other hazardous waste sites before being brought on site.
- Printing and/or writing on well casing, tremie tubing, etc., should be removed before use. Emery
 cloth or sand paper can be used to remove the printing and/or writing. Most well material
 suppliers can supply materials without the printing and/or writing, if specified when ordered.
- The drill rig and other equipment associated with the drilling and sampling activities should be inspected to insure that all oils, greases, hydraulic fluids, etc., have been removed, and all seals and gaskets are intact with no fluid leaks.
- PVC or plastic materials such as tremie tubes should be inspected. Items that cannot be cleaned are not acceptable should be discarded.

4.3 Drill Rig Field Cleaning Procedure

Any portion of the drill rig, backhoe, etc., that is over the borehole (kelly bar or mast, backhoe buckets, drilling platform, hoist or chain pulldowns, spindles, cathead, etc.) should be steam cleaned (soap and high-pressure hot water) between boreholes.

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4.4 Field Cleaning Procedure for Drilling Equipment

The following is the standard procedure for field cleaning augers, drill stems, rods, tools, and associated equipment. This procedure does not apply to well casings, well screens, or split-spoon samplers used to obtain samples for chemical analyses, which should be cleaned as outlined in Section 2.3.

- 1. Clean with tap water and soap, using a brush if necessary, to remove particulate matter and surface films. Steam cleaning (high pressure hot water with soap) may be necessary to remove matter that is difficult to remove with the brush. Drilling equipment that is steam cleaned should be placed on racks or saw horses at least 2 feet above the floor of the decontamination pad. Hollow-stem augers, drill rods, etc., that are hollow or have holes that transmit water or drilling fluids, should be cleaned on the inside with vigorous brushing.
- 2. Rinse thoroughly with tap water.
- 3. Remove from the decontamination pad and cover with clean unused plastic. If stored overnight, the plastic should be secured to ensure that it stays in place.

When there is concern for low-level contaminants, it may be necessary to clean this equipment between borehole drilling and/or monitoring well installation using the procedure outlined in Section 2.3.

5.0 EMERGENCY DISPOSABLE SAMPLE CONTAINER CLEANING

New 1-pint or 1-quart mason jars may be used to collect samples for analyses of organic compounds and metals in waste and soil samples during an emergency. These containers would also be acceptable on an emergency basis for the collection of water samples for extractable organic compounds, pesticides, and metals analyses. These jars cannot be used for the collection of water samples for volatile organic compound analyses.

The rubber sealing ring should not be in contact with the jar and aluminum foil should be used, if possible, between the jar and the sealing ring. If possible, the jar and aluminum foil should be rinsed with pesticide-grade isopropanol and allowed to air dry before use. Several empty bottles and lids should be submitted to the laboratory as blanks for quality control purposes.

OPERATION OF SPECIFIC CONDUCTANCE METER

1.0 PURPOSE AND APPLICABILITY

This Standard Operating Procedure (SOP) provides basic instructions on the field use of specific conductance meters. Refer to the owner's manual for specific instructions.

Conductivity is a measure of the ability of an aqueous solution (e.g., groundwater, surface water, wastewater) to carry an electrical current, and is the inverse of resistivity. The principal by which instruments measure conductance is simple – two conductivity plates are placed in the sample, a potential is applied across the plates (normally a sine wave voltage), and the current is measured. Conductivity is determined from the voltage and current values.

Conductivity depends on the presence of ions, their total concentration, mobility, valence, and relative concentrations and temperature. Pure water has very low conductance. As ion concentrations increase, conductance of the solution increases; therefore, the conductance measurement provides an indication of ion concentration.

Specific conductivity is typically measured in micromhos per centimeter (umhos/cm) or microsiemens per centimeter (uS/cm) at the specific temperature of 25°C. Results are reported to the nearest ten (10) units for readings less than 1,000 umhos/cm at 25°C, and to the nearest one hundreds (100) units for readings greater than 1,000 umhos/cm at 25°C.

Conductivity measurements are temperature dependent. Temperature effects on conductivity are solution-dependent. Meters that have automatic temperature compensation reference the readings to a standard temperature, usually 25°C. Some meters have adjustable temperature compensation which allows adjustment to match the temperature coefficient of the solution.

2.0 RESPONSIBILITIES

The Field Team Leader or his/her designee is responsible for ensuring that the specific conductance meter is in proper operating condition prior to mobilizing. The Field Team Leader is responsible for calibrating the meter in the field and collecting/recording measurements.

3.0 REQUIRED MATERIALS

- Operation and maintenance instruction book;
- Conductivity meter;
- Conductivity cell;
- Standard solution(s) of known conductivity;
- Distilled/deionized water; and
- Thermometer.

4.0 SAFETY PRECAUTIONS

No specific safety precautions are necessary in using this instrument, but care should be taken while handling potentially hazardous materials. However, the project-specific Health and Safety Plan must be complied with at all times. Gloves should be work while handling potentially impacted aqueous samples.

5.0 PROCEDURE

The procedures to be used for instrument calibration and use shall be provided in the instrument-specific operation and maintenance instruction book.

6.0 QUALITY CONTROL

Prior to the specific conductance meter's use in the field, the meter should be tested and checked to ensure good working order. The meter shall be calibrated in the field prior to its use, periodically during the use period when the meter appears to be malfunctioning or giving false readings, during periods of extended use (generally recalibration occurs after approximately 10 readings) and after the use period.

A polarized or fouled electrode must be cleaned or replatinized periodically to renew the active cell surface of the cell (consult instruction manual for cell specific maintenance instructions). For normal applications, hot water with a mild detergent is an effective cleanser. Acetone easily removes most organic foulings. To prevent cell damage, abrasives or sharp objects should not be used to clean the electrode.

7.0 DOCUMENTATION

Record all calibration and sample readings in the field notebook or on a field data sheet. A copy of the field notebook or data sheet will be placed in the project file.

Proprietary Information OPERATION OF pH METER

1.0 PURPOSE AND APPLICABILITY

This Standard Operating Procedure (SOP) provides basic instructions to be employed for the field operation of a pH meter. The pH is defined as the negative logarithm of the effective hydrogen ion concentration or hydrogen-ion activity in gram equivalents per liter on a scale which ranges from 0 to 14, with 7 representing neutrality. Units of pH are Standard Units (SU) and should be read in one-hundredth (0.01 of a unit).

A standard pH measuring system consists of three elements:

- 1) pH electrode;
- 2) temperature compensation element; and
- pH meter.

Temperature compensation is required for accurate, repeatable measurements, because pH values are sensitive to temperature, most pH applications require temperature compensation.

The meter may also have the capability of measuring oxidation-reduction (redox) potential, which is measured in millivolts (mv).

2.0 RESPONSIBILITIES

The Field Team Leader or his/her designee is responsible for ensuring that the pH meter is in proper operating condition prior to mobilizing.

3.0 REQUIRED MATERIALS

- Operation and maintenance instruction book;
- pH meter and additional batteries;
- Buffer solutions, pH of 7.00 and pH 4.00 and/or 10.00;
- Distilled water;
- Chemical-free paper towels;
- Thermometer; and
- Measurement cup.

4.0 SAFETY PRECAUTIONS

No specific safety precautions are necessary in using this instrument, but care should be taken while handling the high and low pH buffer solutions and potentially impacted aqueous samples. The project-specific Health and Safety plan should be followed, and gloves should be worn while handling samples.

5.0 PROCEDURE

The procedures to be used for pH meter calibration and use shall be provided in the instrument-specific operation and maintenance instruction book.

6.0 QUALITY CONTROL

Prior to the pH meter's use in the field, the meter should be checked to ensure that the probe, power pack and associated equipment are in good working order. The meter is to be calibrated in the field prior to its use, periodically during the use period, during the use period when the meter appears to be giving false readings or is suspect, and after the use period.

Electrodes should be rinsed between samples with distilled/deionized water. The pH electrode should always be kept moist. The electrode should be stored in a solution of 4 M KCl. If 4 M KCl is not available, use the pH 4 buffer solution or store the electrode in tap water. Do NOT store the electrode in distilled/deionized water, as this will cause ions to leach from the electrode's glass bulb and render the electrode useless. Most electrodes are shipped in a protective rubber boot over the glass bulb to prevent cracking or scratching. Upon completion of work, the electrode should be stored in the boot, with enough KCl solution to cover the glass bulb.

Never wipe an electrode, as wiping can cause erroneous readings due to static electricity charges. Blot the end of the electrode with lint-free paper to remove excess water.

Measurement of pH in samples containing non-aqueous phase liquids is not recommended.

7.0 DOCUMENTATION

Record all calibration and sample readings in the field notebook or on a field data sheet. A copy of the field notebook or data sheet will be placed in the project file.

OPERATION/CALIBRATION OF HNu PHOTOIONIZATION ANALYZER

1.0 PURPOSE AND APPLICABILITY

This Standard Operating Procedure (SOP) describes the operation and calibration techniques used for the Model PI 101 Photoionization Analyzer. This instrument is designed to measure organic vapor levels. There are three direct reading ranges: 0 to 20 ppm, 0 to 200 ppm and 0 to 2,000 ppm at a minimum gain. The detection limit is 0.1 ppm. The linear range is 0 to 600 ppm. The response time is less than 5 seconds to 90% of full-scale. (All specifications are benzene referred.)

The Pl 101 is capable of operating either from a rechargeable battery for more than 10 hours or continuously from the AC battery charger. The recorder output is 0 to 100 mv FSD (full-scale deflection).

2.0 RESPONSIBILITIES

The Field Team Leader or his/her designee is responsible for ensuring that the analyzer is in proper operating condition prior to leaving the laboratory. The Field Team Leader is also responsible for ensuring that the analyzer is calibrated and operated according to the methods outlined in this SOP.

3.0 REQUIRED MATERIALS

- NBS Traceable span gas cylinders:
 - 1. 10 ppm isobutylene or other appropriate gas in hydrocarbon free air.
 - 2. 150 ppm isobutylene or other appropriate gas in hydrocarbon free air.

NOTE: If NBS traceable gas standards are not available, substitute the manufacturer's certified standard.

- Appropriate gas regulator.
- Tedlar bags, 4 to 5 liters.
- Tubing used for gas transfer from cylinder to bag (if necessary).
- AC battery charger.
- "Magic marker."
- Field notebook.
- Calibration data sheets.
- Activated charcoal.

4.0 SAFETY PRECAUTIONS

Do not look directly into the UV light source of the analyzer. Be careful with the standard gas cylinder when standardizing the instrument.

5.0 PROCEDURE

5.1 Standard Procedure

- 1. Operation and calibration of the instrument should be performed in a controlled environment (i.e., in the field office, interior of a vehicle, etc.). This is done in order to control the working temperature, protect from vehicle exhausts, etc.
- 2. The probe nozzle, electrode casing handle, and cable are stored within the instrument cover. To assemble, the handle must be screwed to the electrode casing. The probe nozzle must be screwed to the opposite end of the electrode casing. The 12-pin connector at the end of the cable must then be attached to the rest of the unit by twisting it downwards until a distinct snap and lock is felt. The unit is now ready to be used.
- 3. Prior to calibration or use of the instrument, the unit should be allowed to warm up for approximately one-half hour. During this time, check to see if the UV light source is working. Do not look directly at the light source. Also, check to see if the intake fan is working properly. The intake fan is located in the electrode casing and will give off a distinct hum when the unit is turned on.
- 4. Check to make sure the level of charge is high enough to ensure accurate readings. When the instrument is switched to the BATTERY CHECK position, the needle should deflect upscale to well within the green area (battery level) on the face of the meter. If not, the unit should be charged using the AC charger. A 3-hour charge will bring the unit up to 90% full charge. With continuous use, (i.e., unit left on for a full day), the unit should be recharged overnight for 8 to 10 hours.

5.2 Calibration and Maintenance

- To ensure accurate readings over the full range of scale that is to be needed, calibration should be
 done at the beginning of each day the instrument is used. Two cylinders containing isobutylene or
 another appropriate gas, of two different known concentrations are to be used as calibration gases. If
 only one cylinder is available, the concentration should be high enough to be within the expected
 range under normal use.
- 2. The instrument should be given the dynamic zero check by connecting the activated charcoal canister to the inlet probe, using flexible tubing, while operating the instrument in the sampling mode. Wait for a stable response and then adjust the zero potentiometer until a zero reading is obtained. This zero check should be performed before and after each calibration. The charcoal in the canister should be replaced at least once every 5 sampling days.
- 3. Actual calibration is done by first filling an evacuated Tedlar bag with gas from the calibration gas cylinder containing the highest gas concentration. Use the available tubing and any other hookup materials that are provided. Be absolutely sure that the Tedlar bag has been evacuated before filling it with gas, otherwise the calibration gas will be diluted and its concentration will not be known.
- 4. The appropriate analyzer scale should be chosen depending on the known concentration of the calibration gas. Attach the probe nozzle to the Tedlar bag and allow it to sample the gas until a

stable, unchanging reading is reported by the analyzer. Adjust the span potentiometer so that the instrument reading agrees exactly with the concentration of the calibration gas. Whenever the span setting is changed, the zeroing procedure should be repeated.

5. The calibration procedure should be repeated for the other calibration as provided, to ensure that the instrument is calibrated properly over a wide range of scale.

5.3 Standard Operation

- 1. After the instrument is fully calibrated, the analyzer is ready to be used. To obtain the most accurate reading, the lowest possible scale should be selected prior to sampling. To analyze a sample, the probe nozzle should be placed in close proximity to the sample, taking care not to contaminate the probe with any materials (soil, water).
- 2. A "magic marker" is provided to check meter responses periodically. When the probe is inserted into the marker cap or next to the marker tip, a reading of about 5 ppm should be obtained. Shelter the probe and marker from any wind when performing this test.
- 3. Meter calibration should be checked at the end of the day with any appropriate changes made and documented.

6.0 QUALITY CONTROL

Prior to using the HNu photoionization analyzer in the field, the analyzer should be tested and checked to ensure good working condition. The analyzer will be calibrated in the field prior to its use and at the end of the use period.

7.0 DOCUMENTATION

Record all calibration information in the field logbook or on the calibration form. Record all sample readings and sample information in the field notebook.

Proprietary Information SURFACE WATER SAMPLING METHODS

1.0 INTRODUCTION

Surface water sampling techniques and equipment are designed to minimize effects on the chemical and physical integrity of the sample. If the guidance provided is followed, a representative sample of the surface water should be obtained.

The physical location of the investigator when collecting a sample may dictate the equipment to be used. If surface water samples are required, direct dipping of the sample container into the stream is desirable. This is possible, however, only from a small boat, a pier, etc., or by wading in the stream. Wading, however, may cause the re-suspension of bottom deposits and bias the sample. Wading is acceptable if the stream has a noticeable current (is not impounded), and the samples are collected while facing upstream. If the stream is too deep to wade, or if the sample must be collected from more than one water depth, or the sample must be collected from a bridge, etc., supplemental sampling equipment must be used.

2.0 SURFACE WATER SAMPLING EQUIPMENT

2.1 Dipping Using Sample Container

A sample may be collected directly into the sample container when the surface water source is accessible by wading or other means. The sampler should face upstream and collect the sample without disturbing the sediment. The surface water sample should always be collected prior to the collection of a sediment sample at the same location. The sampler should be careful not to displace the preservative from a prepreserved sample container such as the 40-ml VOC vial.

2.2 Scoops

Stainless steel scoops are useful for reaching out into a body of water to collect a surface water sample. The scoop may be used directly to collect and transfer a surface water sample to the sample container, or it may be attached to an extension in order to access the selected sampling location. The scoop is one of the most versatile sampling tools available to the field investigator.

2.3 Peristaltic Pumps

Another device that can be effectively used to sample a water column, such as a shallow pond, is the peristaltic pump/vacuum jug system. The use of a metal conduit to which the tubing is attached, allows for the collection of a vertical sample (to about a 25 foot depth) which is representative of the water column. Commercially available pumps vary in size and capability, with some being designed specifically for the simultaneous collection of multiple water samples.

2.4 Discrete Depth Samplers

When discrete samples are desired from a specific depth, and the parameters to be measured do not require a Teflon®-coated sampler, a standard Kemmerer or Van Dorn sampler may be used. The Kemmerer sampler is a brass cylinder with rubber stoppers that leave the ends of the sampler open while being lowered in a vertical position, thus allowing free passage of water through the cylinder. The Van Dorn sampler is plastic and is lowered in a horizontal position. In each case, a messenger is sent down a

rope when the sampler is at the designated depth, to cause the stoppers to close the cylinder, which is then raised. Water is removed through a valve to fill respective sample containers. With a rubber tube attached to the valve, dissolved oxygen sample bottles can be properly filled by allowing an overflow of the water being collected. With multiple depth samples, care should be taken not to stir up the bottom sediment and thus bias the sample.

When metals and organic compounds parameters are of concern, then a double check valve, stainless steel bailer, or Kemmerer sampler should be used to collect the sample.

2.5 Bailers

Teflon® bailers may also be used for surface water sampling, if the study objectives do not necessitate a sample from a discrete interval of the water column. A closed top bailer with a bottom check valve is sufficient for many studies. As the bailer is lowered through the water column, water is continually displaced through the bailer until the desired depth is reached, at which point the bailer is retrieved. This technique may not be successful where strong currents are found.

2.6 Buckets

A plastic bucket can be used to collect samples for *in-situ* analyses, e.g., pH, temperature, and conductivity. However, the bucket should be rinsed twice with the sample water prior to collection of the sample.

SOIL HEAD SPACE SCREENING (FIELD TECHNIQUE)

1.0 MATERIALS

Photoionization detector (PID)
Aluminum foil
Clear 8-oz to 16-oz glass large-mouth containers with lids
Stainless steel spoon
Field notebook

2.0 SURFACE WATER SAMPLING EQUIPMENT

- 1. Check PID to ensure that it is working properly.
- 2. Using KU Resources, Inc.'s standard operating procedure (SOP) for collecting soil, sludge, or sediment, half-fill the clean glass jar with sample. Wrap Teflon® tape around the threads of the jar. Place a piece of aluminum foil over the top of the jar and tightly seal the jar. Label the jar indicating the sampling location, depth, and date. Store the jar upside down until the sample is analyzed.
- 3. If jars are not available, collect the sample using a Ziploc® bag. Seal and label the bag as specified above.
- 4. Shake the sample vigorously for approximately 15 seconds.
- 5. If necessary, warm the sample to room temperature (70°F) by placing the jar in a heated room or vehicle. This step is very important when the ambient temperature is below 32°F.
- 6. After waiting approximately 15 minutes, carefully unscrew the lid of the jar without disturbing the aluminum foil and Teflon® tape. Pierce a hole through the aluminum foil using the tip of the PID. If using Ziploc® bags, open the bag slightly and place the tip of the probe into the opening. Do not insert the probe into the soil, and avoid the uptake of water droplets or soil particulates.
- 7. Following probe insertion, record the highest meter response. Using the foil seal/probe insertion method, maximum response should occur between 2 seconds and 5 seconds. Erratic MD response may occur at high organic vapor concentrations or conditions of elevated headspace moisture in which case the headspace data should be qualified or discounted.
- 8. Record the sample location, depth, medium character (i.e., clay or sand), and PID reading in the field notebook. Also indicate ambient temperature, humidity, and whether moisture was present in the jar. These points are important because, on very cold days, volatilization of organic compounds is reduced and water vapor present in the jar may cause the PID to give a false reading. Be consistent in procedure and in recording of the data.
- 9. Perform a quality assurance/quality control procedure on 10% of the samples. Collect two samples from the same location and follow the SOP outlined above. The head space screening data from both jars should be recorded and compared. Generally, replicate values should be consistent to plus or minus 20%.
- 10. Samples collected for head space screening should not be retained for laboratory analysis. Dispose of the soil and jar appropriately.

Proprietary Information BOREHOLE LOGGING

1.0 INTRODUCTION

This procedure describes the methods followed for classifying soils, rock, and preparing borehole logs and other types of soil reports.

Borehole logging is the systematic observation and recording of geologic and hydrogeologic information from subsurface borings and excavations. In accordance with general practices followed by the profession, the United Soil Classification System (USCS) is used to identify, classify, and describe soils.

The need for consistency in lithologic descriptions cannot be overstressed, especially if several individuals are involved in logging holes during a particular project. Subsequent construction of cross-sections necessary for understanding the geology and hydrogeology of a site depend upon consistent logging description.

2.0 RECOMMENDED MINIMUM REQUIREMENTS

Soil classification and borehole logging should be conducted by a geologist or other professional trained in the classification of soils. In many states, drilling, logging, and other borehole-related activities, such as building wells, must be conducted under the supervision of registered professionals (i.e., geologist or engineer) registered in the designated state.

3.0 EQUIPMENT

The following equipment is required for borehole logging:

- Boring log forms
- Daily inspection report forms
- Chain-of-custody forms
- Request for analysis forms
- USCS Table and Classification Chart
- Soil color chart (i.e., Munsell)
- Grain size and roundness chart
- Graph paper
- Engineer's scale
- Previous reports and boring logs
- · Pocket knife or putty knife
- Hand lens
- Dilute hydrochloric acid (10% volume)
- Gloves
- · Personal protective clothing and equipment, as described in the project health and safety plan
- Insulated sample storage and shipping containers (i.e., ice chests) and ice (not blue ice)
- Aluminum foil and paper towels

4.0 PROCEDURE FOR SOIL CLASSIFICATION

Soils are typically logged in conjunction with advancing boreholes and sampling subsurface soils. Although the procedure focuses on classifying soil samples obtained from boreholes, the procedure described below also applies to soils and sediments collected using other techniques (e.g., post hole digger, scoop, Van Veen sampler, hand-augers, and backhoes.)

The USCS categorizes soils into 15 basic groups with distinct geologic and engineering properties. The following steps are required to classify a soil sample:

- 1. Observe basic properties and characteristics of the soil. These include grain-size grading, and distribution, color, and influence of moisture on fine-grained soil.
- 2. Assign the soil a USCS classification and denote it by the standard group name and symbol.
- 3. Provide a written description to differentiate between soils in the same group, if necessary.

Many soils have characteristics that are not clearly associated with a specific soil group. These soils might be near the borderline between groups, based on either grain-size grading and distribution or distribution of plasticity characteristics. In such a case, assigning dual group names and symbols (e.g., GW/GC or ML/CL) might be an appropriate method of describing the soil. The two basic soils groups, coarse- and fine-grained soils, are discussed in the following sections.

4.1 Coarse Grained Soils

4.1.1 Classification

For soils in the coarse-grained soils group, more than half of the material in the soil matrix is larger than No. 200 sieve (0.074 mm). Coarse-grained soils are classified on the basis of:

- 1. grain size and distribution,
- 2. quantity of fine-grained material (i.e., silt and clay as a percentage), and
- 3. character of fine-grained material.

Classification uses the following symbols:

Basic Symbols
G = gravel
W = well graded
S = sand
P = poorly graded
M = with silty fines
C = with clayey fines

The following basic facts apply to coarse-grained soil classification.

- The basic symbol G is used if the estimated percentage of gravel is greater than that for sand. In contrast, the symbol S is used when the estimated percentage of sand is greater than the percentage of gravel.
- Gravels range in size from 3-inch to 1/4-inch (No. 4 sieve) diameter. Sands range in size from
 the No. 4 sieve to No. 200 sieve. The Grain Size Scale used by Engineers (ASTM Standards D
 422-63 and D 643-78) is the appropriate method to further classify grain size as specified by the
 USCS. (Note: This grain size scale differs from the Modified Wentworth Scale used by most
 geologists. It introduces a distinction between sorting and grading.)
- Modifying symbol W indicates good representation of all particle sizes.
- Modifying symbol P indicates that there is an excess or absence of particular sizes.
- The symbol W or P is used only when there is less than 15 percent fines in a sample.
- Modifying symbol M is used if fines have little or no plasticity (silty).
- Modifying symbol C is used if fines have low to high plasticity (clayey).
- The following rules apply for the written description of the soil group name:

Types of Soil	<u>Rule</u>
Sands and gravels	Less than 5 percent fines
Sands (or gravels)	5 to 15 percent fines with fines
Silty (or clayey)	Greater than 15 percent fines sands or gravels.

4.1.2 Other Parameters

Designate relative density for sands and gravels using blow count data, recording the number of blows for each 6 inches in field log, but only the number of blows for the last 1 foot in the final log (or the number of blows for the amount of penetration obtained). The following are some "rule-of-thumb" guidelines:

Blow Count	Relative Density for Sands and Silts	
0 - 4	Very loose	
4 - 10	Loose	
10 - 30	Medium dense	
30 - 50	Dense	
> 50	Very dense	

Record the color/discoloration of the sample. Name it according to the Munsell Soil Color Chart for soils or the GSA Rock Color Chart for rocks. Do not describe soil color using the rock chart, or vice versa. If

you have only one of the color charts, indicate so on the log. Write the color identification in parenthesis following the color name: (10 YR, 3/2).

Record the approximate percentage of gravel, sand, and fines (use a percentage estimation chart):

<u>Modifiers</u>	<u>Descriptions</u>	
Trace	Less than 5 percent	
Few	5 to 10 percent	
Little	15 to 25 percent	
Some	30 to 45 percent	
Mostly	50 to 100 percent	

Other parameters to record include maximum grain size, mineralogic composition of grains, mineralogy, grain shape (round, subround, angular, subangular), in-place moisture content (dry, moist, or wet), structure, presence of organic material, cementation by carbonates or silicates, free calcium carbonate (check for effervescence with HCl), and odor.

4.2 Fine-Grained Soils

4.2.1 Classification

If one-half or more of the material is smaller than No. 200 sieve (0.074 mm) the soil is classified as fine-grained. Fine-grained soils are classified on the basis of:

- 1. Liquid limit
- 2. Plasticity

Classification of fine-grained soils uses the following symbols:

Basic Symbols	Modifying Symbols	
M = silt (non-plastic)	L = low liquid limit (Lean)	
C = clay (plastic)	H = high liquid limit (Fat)	
O = organic		
Pt = peat		

The following basic facts apply to fine-grained soil classification:

- The basic symbol M is used if the soil is mostly silt, while the symbol C applies if it consists mostly of clay. Use of symbol 0 indicates that organic matter is present in an amount sufficient to influence soil properties. The symbol Pt indicates soil that consists mostly of organic material.
- Modifying symbols (L and H) are based on the following hand tests conducted on a soil sample:

- Dry strength (crushing resistance)
- Dilatency (reaction to shaking)
- Toughness (consistency near plastic limit)
- Soil designated ML has little or no plasticity and can be recognized by slight dry strength, quick dilatency, and slight toughness.
- CL indicates soil with slight to medium plasticity, which can be recognized by medium to high dry strength, very slow dilatency, and medium toughness.
- OL is used to describe a soil that is less plastic than CL soil and can be recognized by slight to medium dry strength, medium to slow dilatency, organic content, color, odor, and slight toughness.
- MH soil has slight to medium plasticity and can be recognized by low dry strength, slow dilatency, and slight to medium toughness.
- Soil designated CH has high plasticity and is recognizable by its high dry strength, no dilatency, and high toughness.
- OH soil is less plastic than CH soil and can be recognized by medium to high dry strength, slow dilatency, and slight to medium toughness.

4.2.2 Other Parameters

Record consistency for clayey silts and clays using blow count data, recording the number of blows for each 6 inches in field log, but only the number of blows for the last 1 foot in the final log (or the number of blows for the amount of penetration obtained). The following are some "rule-of-thumb" guidelines:

Blow <u>Count</u>	Consistency for Clays	<u>Description</u>
0 - 2	Very Soft	Sample sags or slumps under its own weight
2 - 4	Soft	Sample can be pinched in two between the thumb and forefinger
4 - 8	Firm	Sample can be easily imprinted with fingers
8 -16	Stiff	Sample can be imprinted only with considerable pressure of fingers
16 -32	Very Stiff	Sample can be imprinted very slightly with fingers
> - 32	Hard	Sample cannot be imprinted with fingers; can be pierced with pencil

Other descriptive information to be included is color, moisture content, structure compactness (loose, dense) for silts, results of a pocket torvane test in tons per square foot (in clayey soils only), results of a pocket penetrometer test in tons per square foot, and odor.

5.0 PROCEDURES FOR ROCK CLASSIFICATION

For rock classification record mineralogy, texture, and structural features (e.g., biotite and quartz fine grains, foliated parallel to relict bedding oriented 15 to 20 degrees to core axis, joints coated with iron oxide). Describe the physical characteristics of the rock which are important for engineering considerations such as fracturing (including minimum, maximum, and most common and degree of spacing), hardness, and weathering. The following is to be used as a guide for assessing fracturing:

AEG Fracturing	<u>Spacing</u>
Course	un to 0.4 foot
Crushed	up to 0.1 foot
Intense	0.1 foot - 0.5 foot
Moderate	0.5 foot - 10. foot
Slight	1.0 foot - 3.0 foot
Massive	>3.0 foot

Record hardness using the following guidelines:

<u>Hardness</u> <u>Criteria</u>

Soft Reserved for plastic material

Friable Easily crumbled by finger pressure

Low Deeply gouged or carved with pocket knife

Moderate Readily scratched with knife; scratch leaves heavy trace of dust

Hard Difficult to scratch with knife; scratch produces little powder and is often faintly visible

Very Hard Cannot be scratched with knife

Describe weathering using the following guidelines:

	Decomposition	Discoloration	Fracture Condition
Deep	Moderate to complete alteration of minerals feldspars altered to clay, etc.	Deep and thorough	
Moderate	Slight alteration of minerals, cleavage surface lusterless and stained	Moderate or localized and intense	All fractures coated with oxides, carbonates, or clay
Weak	No megascopic alteration of minerals	Slight and intermittent and localized	Thin coatings or stains
Fresh	Unaltered, cleavage, surface glistening		

6.0 PROCEDURE FOR LOGGING REFUSE

The following procedure applies to the logging of subsurface samples composed of various materials in addition to soils as may be collected from a landfill or other waste disposal site.

- 1. Observe refuse as it is brought up by the hollow-stem auger, bucket auger, or backhoe.
- 2. If necessary, place the refuse in a plastic bag to examine the sample.
- 3. Record observations according to the following criteria:
 - a. Composition (by relative volume), e.g., paper, wood, plastic, cloth, cement, or construction debris. Use such terms as "mostly" or at least half. Do not use percentages.
 - b. Moisture content: dry, damp, moist, wet.
 - c. State of decomposition: highly decomposed, moderately decomposed, slightly decomposed, etc.
 - d. Color obvious mottling and/or degree of mottling.
 - e. Texture: spongy, plastic (cohesive), friable.
 - f. Odor.
 - g. Combustible gas readings (measure downhole and at surface).
 - h. Miscellaneous: dates of periodicals and newspapers, ability to read printed materials, degree of drilling effort (easy, difficult, very difficult).

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Proprietary Information UNDERGROUND UTILITY LOCATING

1.0 INTRODUCTION

The purpose of this procedure is to ensure that all subsurface utilities (e.g., electrical lines, gas lines, telephone lines) are located and marked before initiating any intrusive activities (drilling, test pits, trenching). Compliance with this procedure will allow the work to be conducted safely and will minimize the potential for damaging underground utilities.

2.0 MATERIALS

- Record of the communication utility locating form
- Bound field log book
- Wooden stakes
- Spray paint
- Flagging tape
- As-built subgrade utility drawing(s) (if available)
- · Hand auger or post-hole digger
- Hand-held magnetic and/or cable locator
- Facility as-built drawings

3.0 PROCEDURE

Pre-site Mobilization

- 1. Gather information on the on-site and off-site areas where intrusive activities will be conducted. This information should include the following:
 - Site address
 - Nearest cross street or street intersection
 - Map grid (if applicable)
 - Site boundaries
- 2. Contact the local utility service at least 72 hours before the start of the field activities. The telephone number is typically listed in the area Yellow Pages. Provide the utility locating service with any information they request concerning the site and work activity in order to locate utilities at the site. (In California, the proposed drilling locations must be marked with white spray paint before contacting the locating services.) The following information provided by the locating service should be documented in a record of communication utility locating form: utilities to be located and their corresponding colors, and utility clearance ticket number. The ticket number will be used by the various utility companies to reference the clearance request (see note below). The public utility companies will typically mark their lines up to the property lines unless a junction box or meter is present on the site; however, request that the utility companies mark their utilities in the work areas on the site.

Note: Some utilities (e.g., sewer, water, cable TV) may not be included with the utility locating service. These utility companies will have to be contacted directly for clearance before the start of intrusive activities.

- 3. If the field activities need to be started before the end of the 72-hour notification period, determines whether the locating service can expedite the request. As a general rule, no intrusive activities should be conducted along or near public rights-of-way until all utilities have been checked and marked in the area of investigation. Field activities may be conducted on private property if sufficient information is available to locate all underground utilities.
- 4. Identify a site contract familiar with the utilities on the property (e.g., plant manager, facility engineer, maintenance supervisor), and provide this individual with a site plan showing the proposed locations of all soil borings, monitoring wells, test pits, and other areas where intrusive activities will be conducted.

Site Mobilization

- 1. Locate all proposed drilling and trenching locations, both on site and off site, with spray paint, stakes, or other appropriate markers.
- 2. Verify that all utility companies listed by municipal locating service have marked all underground lines in the area, and whether the lines have been marked.
- 3. Review all available as-built utility diagrams and plans with the site contact to identify potential areas where underground lines may be present. If possible, obtain a copy(s) of the utility plans for future reference in the field. Check the drawings to ensure they are as-builts and not design plans. (Note: As-built drawings are not always accurate for locating underground lines.)
- 4. Conduct a walk the site contact and clear each proposed work area using the utility markings and information provided on the as-built plans. A minimum of 4 feet clearance should exist between utilities and proposed drilling locations, and a minimum of 6 feet between utilities and proposed trenching locations. If a utility conflict is identified, adjust the proposed location(s) using the criteria given above.
 - During the site walk-through, attempt to obtain a general knowledge of the types of utilities present in the work areas. Check to see whether major electrical lines are aboveground. The presence of aboveground lines may indicate that there are non-underground lines in that portion of the site. Underground sewer lines may be traced using the locations of manholes and storm water grates.
- 5. A private utility locating service should be contracted in cases where the public utility locating service does not mark utilities on the subject property and site-specific information concerning the type and location of potential underground lines is poor or non-existent.

- 6. In areas where uncertainty still exists concerning the presence of underground utilities, a hand auger or post-hole digger should be used to probe the shallow subsurface before using any heavy equipment (drill rig, backhoe). The probe hole should be advanced a minimum of 4 feet below ground surface at each proposed drilling location. A sufficient number of probe holes should be completed so that the area is cleared for the proposed intrusive activity. For drilling, a minimum of three holes should be advanced at each location.
- 7. Discuss the site conditions with the subcontractor (e.g., driller, excavator), and recommend that care be used at the start of the intrusive activities. Field personnel should always consider the presence of unidentified utilities at each work area. Ensure the work is conducted safely.
- 8. If the scope of the intrusive activities expands to a new on-site or off-site area(s), review the existing information to determine whether the area(s) can be safely cleared of all potential underground utilities. If necessary, contact the municipal locating service and request another clearance for the new area(s) of investigation. (Remember, the new request will require another 72-hour period before all underground utilities can be cleared.)

Proprietary Information WELL ABANDONMENT PROCEDURES

1.0 INTRODUCTION

Unsealed or improperly sealed wells may threaten public health and safety, and the quality of the groundwater resources. Therefore, the proper abandonment (decommissioning) of a well is a critical final step in its service life. Act 610, the Water Well Drillers License Act, includes a provision for abandonment of wells. This legislation makes it the responsibility of a well owner to properly seal an abandoned well according to the rules and regulations of the Department of Conservation and Natural Resources (DCNR). In the absence of more stringent regulatory standards, the procedures outlined in this section represent minimum guidelines for proper abandonment of wells and borings. These procedures may be applicable for, but not limited to, public and domestic water supply wells, monitoring wells, borings or drive points drilled to collect subsurface information, test borings for groundwater exploration, and dry wells (drains or borings to the subsurface). Proper well abandonment accomplishes the following: 1) eliminates the physical hazard of the well (the hole in the ground), 2) eliminates a pathway for migration of contamination, and 3) prevents hydrologic changes in the aquifer system, such as the changes in hydraulic head and the mixing of water between aquifers. The proper decommissioning method will depend on both the reason for abandonment and the condition and construction details of the boring or well.

2.0 WELL CHARACTERIZATION

Effective abandonment depends on knowledge of the well construction, geology, and the hydrogeology. The importance of a full characterization increases as the complexity of the well construction, site geology, and the risk of aquifer contamination increases. Construction information for wells drilled since 1966 may be available from DCNR, Bureau of Topographic and Geologic Survey's (BTGS) Water Well Inventory System database. Additional well construction data and information describing the hydrologic characteristics of geologic formations may be available from reports published by BTGS and the U.S. Geological Survey (USGS). Site or program records also may exist. The well should be positively identified before initiating the abandonment. Field information should be compared with any existing information. Water levels and well depths can be measured with a well sounder or weighted tape measure. In critical situations, well construction details and hydrogeology can be determined with borehole geophysics or a downhole camera. For example, a caliper log, which is used to determine the borehole diameter, can be very helpful in locating cavernous areas in open hole wells.

3.0 WELL PREPARATION

If possible, the borehole must be cleared of obstructions prior to abandonment. Obstructions such as pumps, pipes, wiring, and air lines must be pulled. Well preparation also may involve fishing obstacles out of the borehole. An attempt should be made to pull the casing when it will not jeopardize the integrity of the borehole. Before the casing is pulled, the well should be grouted to near the bottom of the casing. This will at least provide some seal if the well collapses after the casing is pulled. The presence of nested or telescoped casing strings complicates well abandonment. Inner strings should be removed when possible, but only when removal will not jeopardize the abandonment of the well. If inner strings cannot be removed, and sealing of the annular space is required, then the inner string should be vertically split (plastic cased wells) or cut (metal-cased wells) at intervals necessary to insure complete filling of the annular space. Damaged, poorly constructed, or dilapidated wells may need to be redrilled in order to

apply proper abandonment techniques. Also, in situations where intermixing of aquifers is likely, the borehole may need to be redrilled.

4.0 MATERIALS AND METHODS

4.1 Aggregate

If possible, the borehole must be cleared of obstructions prior to abandonment. Obstructions such as pumps, pipes, wiring, and air lines must be pulled. Well preparation also may involve fishing obstacles out of the borehole. An attempt should be made to pull the casing when it will not jeopardize the integrity of the borehole. Before the casing is pulled, the well should be grouted to near the bottom of the casing. This will at least provide some seal if the well collapses after the casing is pulled. The presence of nested or telescoped casing strings complicates well abandonment. Inner strings should be removed when possible, but only when removal will not jeopardize the abandonment of the well. If inner strings cannot be removed, and sealing of the annular space is required, then the inner string should be vertically split (plastic cased wells) or cut (metal-cased wells) at intervals necessary to insure complete filling of the annular space. Damaged, poorly constructed, or dilapidated wells may need to be redrilled in order to apply proper abandonment techniques. Also, in situations where intermixing of aquifers is likely, the borehole may need to be redrilled.

4.2 Sealants

Sealants are used in well abandonment to provide a watertight barrier to the migration of water in the well bore, in the annular spaces, or in fractures and openings adjacent to the well bore. Sealants usually consist of Portland cement-based grouts, "bentonite" clay, or combinations of these substances. Additives are frequently used to enhance or delay specific properties such as viscosity, setting time, shrinkage, or strength. Sealing mixtures should be formulated to minimize shrinkage and ensure compatibility with the chemistry of the groundwater in the well. A grout pump and tremie pipe are preferred for delivering grout to the bottom of the well. This method insures the positive displacement of the water in the well, and will minimize dilution or separation of the grout.

If aggregate is to be placed above sealant, a sufficient amount of curing time should pass before placing the aggregate above the seal. Curing time for grout using Type 1 cement is typically 24-48 hours, and 12 hours for Type III cement. General types of sealants are defined as follows:

Neat cement grout: Neat cement grout is generally formulated using a ratio of one 94-pound bag of Portland cement to no more than 6 gallons of water. This grout is superior for sealing small openings, for penetrating any annular space outside of the casings, and for filling voids in the surrounding rocks. When applied under pressure, neat cement grout is strongly favored for sealing artesian wells or those penetrating more than one aquifer. Neat cement grout is generally preferred to concrete grout because it avoids the problem of separation of the aggregate and the cement. Neat cement grout can be susceptible to shrinkage and the heat of hydration can possibly damage some plastic casing materials.

Concrete grout: Concrete grout consists of a ratio of not more than 6 gallons of water, one 94-pound. bag of Portland cement, and an equal volume of sand. This grout is generally used for filling the upper part of the well above the water-bearing zone, for plugging short sections of casings, or for filling large-diameter

wells. Concrete grout, which makes a stronger seal than neat cement, may not significantly penetrate seams, crevices, or interstices. Grout pumps can handle sand without being immediately damaged. Aggregate particles bigger than this may damage the pump. If not properly emplaced, the aggregate is apt to separate from the cement. Concrete grout should generally not be placed below the water level in a well, unless a tremie pipe and a grout pump are used.

Grout additives: Some bentonite (2 to 8 percent) can be added to neat cement or concrete grout to decrease the amount of shrinkage. Other additives can be used to alter the curing time or the permeability of the grout. For example, calcium chloride can be used as a curing accelerator. High-solids sodium bentonite: This type of grout is composed of 15-20 percent solids content by weight of sodium bentonite when mixed with water. To determine the percentage content, the weight of bentonite is divided by the weight of the water plus the weight of the bentonite. For example, if 75 pounds of powdered bentonite and 250 pounds of granular bentonite were mixed in 150 gallons of water (at 8.34 pounds per gallon), the percentage of high-solids bentonite is approximately 20 percent (325/(1251+325)). High-solids bentonite must be pumped before its viscosity is lowered. Pumping pressures higher than those used for cement grouts are usually necessary. Hydration of the bentonite must be delayed until it has been placed down the well. This can be done by 1) using additives with the dry bentonite or in the water, 2) mixing calcium bentonite (it expands less) with sodium bentonite, or 3) using granular bentonite, which has less surface area. In addition, positive displacement pumps such as piston, gear, and moyno (progressive cavity) pumps must be used because pumps that shear the grout (such as centrifugal pumps) will accelerate the congealing of the bentonite. A paddle mixer is typically used to mix the grout. A high-solids bentonite grout is not made from bentonite that is labeled as drilling fluid or gel.

Chip Bentonite: Chip (coarse grade) or pelletized bentonite can form adequate seals. This type of bentonite is poured directly down the borehole. The size of the bentonite chips also should be no more than 1/4 of the minimum well diameter through which it must pass during placement. Because of the potential for bridging, this material may not be suitable for deep wells or borings where positive displacement is necessary to seal the well. When coarse bentonite is placed above the water level, water must be added frequently to hydrate the bentonite. Care must be taken with chip or palletized bentonite to not overload the interval to be sealed. Rapidly swelling bentonite could result in incomplete hydration and a heterogeneous seal containing lumps of dry bentonite. The level of the bentonite should be checked often to make sure that bridging of the chips does not occur.

4.3 Bridge Seals

A bridge seal can be used to isolate cavernous sections of a well, to isolate two producing zones in the well, or to provide the structural integrity necessary to support overlying materials (and thus protect underlying aggregate or sealants from excessive compressive forces). Bridge seals are usually constructed by installing an expandable plug made of wood, neoprene, or a pneumatic or other mechanical packer. Additional aggregate can be placed above the bridge.

5.0 RECOMENDATIONS

The complexity of the abandonment procedure depends primarily on the hydrogeology, geology, well construction, and the groundwater quality. Four principal complicating factors have been identified; they

include 1) artesian conditions, 2) multiple aquifers, 3) cavernous rocks, and 4) the threat or presence of contamination. The recommended procedures for abandoning wells will be more rigorous with the presence of one or more complicating factors. The procedures may vary from a simple casing seal above aggregate to entirely grouting a well using a tremie pipe after existing casing has been ripped or perforated.

5.1 Casing Seal

The transition from well casing to open borehole is the most suspect zone for migration of water. In order to minimize the movement of water (contaminated or otherwise) from the overlying less consolidated materials to the lower water-bearing units, this zone must be sealed. Generally this can be accomplished by filling at least the upper 10 feet of open borehole and the lower 5 feet of casing with sealant. The length of open borehole sealed should be increased if extenuating circumstances exist. Such circumstances would include a history of bacterial contamination, saprolitic bedrock, or possibly deep fracture zones. Water-bearing zones reported in the upper 20 feet or so of open borehole are indications of fractures and would warrant additional sealant. Casing that is deteriorated should be sealed along its entire length. If the casing is to be pulled the sealant used should remain fluid for a period of time adequate for removal of the casing. If the casing is to remain, then whenever feasible, it should be cut off below land surface. After the casing seal discussed above achieves adequate strength, the open casing should at a minimum, be filled with aggregate. It is strongly suggested that a sealant be used in the upper 2-5 feet of casing.

5.2 Wells in Unconfined or Semi-Confined Conditions

These are the most common type of wells in Pennsylvania. The geology may consist of either unconsolidated or consolidated materials. When applicable, unconfined wells in non-contaminated areas may be satisfactorily abandoned using aggregate materials up to 10-15 feet below the ground surface. This would apply mainly to domestic wells, and test borings or wells not covered by existing regulations. Monitoring wells that are not covered by specific regulatory programs and are located at sites with no known contamination, might be abandoned in this manner. Above the aggregate, the casing seal should be installed. A sealant may be used over the entire depth.

5.3 Wells at Contaminated Sites

An abandoned, contaminated well often mixes contaminated groundwater with uncontaminated groundwater. Complete and uniform sealing of the well from the bottom to the surface is required. Therefore, proper well preparation must be done before the well is sealed with a proper sealant.

5.4 Wells in Cavernous Rocks

Problems can arise when filling wells that penetrate cavernous rock. Although such wells are usually located in carbonate terrain, voids can also occur in areas that have been deep mined. Care must be taken to insure that aggregates and sealants are of a size and consistency to prevent their removal by water flowing in the void. Large voids or high-flow velocities warrant placement of a bridge in competent rock over the void. Aggregate and sealants can then be placed above the bridge.

5.5 Multiple Aquifer Wells

The main goal in sealing wells that extend into more than one aquifer is to prevent the flow of groundwater from one aquifer to another. If no appreciable movement of water is encountered, and there is no threat of groundwater contamination, sealing with concrete, neat cement, grout, or alternating layers of these materials and aggregate will prove satisfactory. When groundwater velocities are high, the procedures for wells with artesian flow (see the next section) are recommended. If alternating plugs (or bridges) and aggregate layers are used, the plugs should be placed in known non-productive horizons or, if locations of the non-productive horizons are not known, at frequent intervals.

5.6 Flowing Wells

The sealing of artesian wells requires special attention. The flow of groundwater may be sufficient to make sealing by gravity placement of concrete, cement grout, neat cement, clay or sand impractical. In such wells, large stone aggregate (not more than 1/4 of the diameter of the hole), well packers (pneumatic or other), or wooden plugs will be needed to restrict the flow and thereby permit the gravity placement of sealing material above the zone where water is produced. If plugs are used, they should be several times longer than the diameter of the well to prevent tilting. Seals should be designed to withstand the maximum anticipated hydraulic head of the artesian aquifer. Because it is very important in wells of this type to prevent circulation between water-yielding zones, or loss of water to the surface or to the annular spacing outside of the casing, it is recommended that pressure grouting with cement be done using the minimum volume of water during mixing that will permit handling. In wells in which the hydrostatic head producing flow to the surface is low, the movement of water may be stopped by extending the well casing to an elevation above the artesian pressure surface.

5.7 Wells with Complicating Factors at Contaminated Sites

Wells with one or more of the above complicating factors that are to be abandoned in areas with contaminated groundwater or in areas where the groundwater is at a high risk for future contamination, require the most rigorous abandonment procedures. In general, the entire length of these wells should be sealed. When the threat of contamination has been established, the elimination of a potential flowpath is critical. For example, a contaminated well in a karst terrain must be carefully sealed to avoid worsening the situation. In general, the entire lengths of these wells should be sealed. In some situations, a bridge seal may have to be installed, and casing may have to be perforated. In each case, a prudent method should be selected that will eliminate all potential vertical flowpaths.

5.8 Monitoring Wells

Monitoring wells should be abandoned in accordance with the rules and regulations of the program under which they were installed and operated. Monitoring wells which do not fall under the jurisdiction of a regulatory program, or fall under a program that has no rules or regulations for abandonment, should be abandoned under the following guidelines. Monitoring wells that were installed and continue to function as designed, can usually be abandoned in place. Exceptions would include wells whose design precludes complete and effective placement of sealant and wells in locations subject to future disturbance that could compromise the abandonment. In such instances all tubing, screens, casings, aggregate, backfilling, and sealant should be cleaned from the boring and the hole should be completely filled with an appropriate sealant. Monitoring wells that are abandoned in place should be completely filled with sealant. Screened intervals can be backfilled with inert aggregate if sealant will alter the groundwater

chemistry and thereby jeopardize ongoing monitoring at the facility. Intervals between screens, and between the last screen and the surface, must be filled with sealant. Generally, sealant must be emplaced from the bottom of the interval being sealed. Protective casings, riser pipes, tubing, and other appurtenances at the surface which could not be removed should be cut off below grade after the sealant has properly set. When the abandonment will be completed below the finished grade, the area of the boring should be covered with a layer of bentonite, grout, concrete, or other sealant before backfilling to grade.

6.0 EXISTING REGULATIONS AND STANDARDS

The Water Well Drillers License Act requires that the owner or consultant who is to abandon the well notify the DCNR Bureau of Topographic and Geologic Survey of the intent to decommission a well at least 10 days before the well is sealed or filled. Individual DEP bureaus may have specific regulations or guidelines. The Bureau of Oil and Gas Management regulates the plugging of oil and gas wells. Plugging provisions for oil and gas wells in coal and non-coal areas are established in § 210 and § 211 of Act 223, and § 78.91 - 78.97 of Chapter 78. These sections describe methods that would stop any vertical flow of fluids or gas within the well bore. Alternate methods of plugging also are allowed if they would afford the same level of protection. Alternate methods must be approved before the plugging is initiated. The Bureau of Mining and Reclamation regulates the abandonment of borings and wells associated with the mining of coal. Coal exploration holes must be abandoned according to § 87.93 for surface mining of bituminous coal, § 88.83 for anthracite coal mining, § 89.54 for deep mining of bituminous coal, and § 90.93 for coal refuse disposal. The Bureau of Water Supply and Wastewater Management uses the AWWA Standard for Water Wells for abandonment of public water supply wells. This standard is referenced in Part II of the Public Water Supply Manual.

7.0 REPORTING

All abandoned wells shall be reported to BTGS, along with any bureau that requires a report, on forms required by BTGS (and any other forms). If available, the original driller's log should be included along with the details of the well abandonment procedure. A photograph should be taken of the site, and a reference map should be made to locate the abandoned well. It also may be appropriate to survey the exact location of the well. This is especially important for wells associated with contaminated sites.

8.0 REFERENCES

AMERICAN WATER WORKS ASSOCIATION, 1990, Abandonment of Test Holes, partially completed wells and completed wells: AWWA Standard for Water Wells, pp. 25-26.

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HANDLING OF INVESTIGATION-DERIVED WASTE

1.0 PURPOSE

Management of investigation-derived waste minimizes the potential for the spread of hazardous waste on site or off site through investigation activities. The purpose of this Standard Operating Procedure is to provide instructions for the proper management of contaminated materials derived from the field investigations.

2.0 INTRODUCTION

Materials that are known or suspected to be contaminated with hazardous substances through the actions of sample collection or personnel and equipment decontamination are said to be investigation-derived wastes. These wastes include decontamination solutions, disposable equipment, drill cuttings and fluids, and groundwater monitoring well development and purge waters. To the extent possible, the site manager will attempt to minimize the generation of these wastes through careful design of decontamination schemes and groundwater sampling programs. Testing conducted on soil and water investigation-derived wastes will show if they are also hazardous wastes as defined by Resource Conservation and Recovery Act. This will determine the proper handling and ultimate disposal requirements.

The criteria for designating a substance a hazardous waste according to RCRA is provided in 40 CFR 261.3. If investigation-derived wastes meet these criteria, RCRA requirements must be followed for packaging, labeling, transporting, storing and record keeping as described in 40 CFR 262.34 Those wastes judged to potentially meet the criteria for hazardous wastes shall be stored in DOT approved 55-gallon steel drums.

Wastes that can be shown not to be RCRA-designated hazardous wastes may be handled and disposed on site or off site to municipal wastewater and/or solid waste systems at direction of the U.S. EPA RPM. Investigation-derived waste is assumed to be RCRA-designated hazardous waste, unless analytical evidence indicates otherwise.

3.0 INVESTIGATION-DERIVED WASTE MANAGEMENT

Procedures that minimize potential for the spread of hazardous waste include minimizing the volume of waste generated, waste segregation, appropriate storage, and disposal according to RCRA requirements.

3.1 Waste Minimization

Within the absolute constraints demanded by worker health and safety and project quality assurance/quality control, the generation of investigation-derived wastes is to be limited. In the development of the investigation work plan, each aspect of the investigation is to be reviewed to identify areas where excess waste generation can be eliminated. General procedures which will eliminate waste include avoidance of unnecessary exposure of materials to hazardous waste, and coordination of sampling schedules to avoid repetitious purging of wells and use of sampling equipment.

3.2 Waste Segregation

Waste storage and handling procedures to be used depend upon the type of generated waste. For this

reason, investigation-derived hazardous wastes described below are segregated into separate 55-gallon storage drums. Waste materials that are known free of hazardous waste contamination (such as broken sample bottles or equipment containers and wrappings) must be collected separately for disposal to municipal systems. Large plastic garbage or lawn and leaf bags are useful for collecting this trash. Even "clean" sample bottles or Tyvek should be disposed with care. Even though they are not legally a problem, if they are discovered by the public they may cause tremendous panic. Therefore, items that are known to be free from contamination but are also known to represent "hazardous or toxic waste" to the public, must not be disposed into any public dumpster such as found at your hotel or park. Items free from contamination may be freely transported until an appropriate disposal site is found.

3.2.1 Decontamination Solutions

Decontamination solutions are generated from the washing and rinsing of personal protective equipment and sampling equipment. Solutions considered investigation-derived wastes range from detergents, organic solvents and acids used to decontaminate small hand samplers to steam cleaning rinsate used to wash drill rigs and other large equipment. These solutions are to be stored in 55-gallon drums with bolt-sealed lids.

3.2.2 Soil Cuttings and Drilling Muds

Soil cuttings are solid to semi-solid soils generated during trenching activities or drilling for the collection of subsurface soil samples or the installation of monitoring wells. Depending on the type of drilling, drilling fluids known as "muds" may be used to remove soil cuttings. Drilling fluids flushed from the borehole must be directed into a settling section of a mud pit. This allows reuse of the decanted fluids after removal of the settled sediments. Drill cuttings, whether generated with or without drilling fluids, are to be removed with a flat-bottomed shovel and stored in 55-gallon drums with bolt-sealed lids.

3.2.3 Well Development and Purge Waters

Well development and purge waters are groundwaters removed from monitoring wells to repair damage to the aquifer following well installation, obtain characteristic aquifer groundwater samples, or measure aquifer hydraulic properties. The volume of groundwater to be generated will determine the appropriate storage procedure. Well purging and well development will generate approximately two to ten well casing volumes of groundwater. This volume can be stored in 55-gallon drums. Measurement of aquifer properties through pump tests can generate significantly greater volumes of groundwater depending on the well yield and the duration of the test. Use of the large-volume portable tanks such "Baker Tanks" should be considered for temporary storage pending results of groundwater analysis.

3.2.4 Disposable Equipment

Disposable equipment includes used personal protective gear such as Tyvek coveralls, gloves, booties and APR cartridges and some inexpensive sampling equipment such as trowels or disposable bailers. This equipment is assumed to be contaminated if it is used at a hazardous waste site, because it is impractical to submit these items for analysis. These materials are to be stored on site in 55-gallon drums, pending final disposal.

3.3 Waste Storage

The wastes that are accumulated through investigations must be stored on site prior to disposal. An onsite waste staging area should be designated to provide a secure and controlled storage for the drums. Per RCRA requirements, storage cannot exceed 90 days for materials presumed or shown to be RCRAdesignated hazardous wastes; waste which is known not to be RCRA-designated wastes should be promptly disposed to municipal waste systems.

3.3.1 Storage Containers

Containers shall be DOT approved (DOT 17H 18/16GA OH unlined) open-head steel drums. The lids should lift completely off the drum, and be secured by a bolt ring. Order enough drums to store all anticipated purge water (at least five times the well casing volume), plus extra drums for solid waste and decon water. Solid and liquid wastes are not to be mixed in the drums. A typical decon line uses approximately 30 gallons of water.

Pallets are often required to allow transport of filled drums to the staging area with a forklift. Normal pallets are 3' x 4' and will hold two to three 55-gallon drums, depending on the filled weight. If pallets are required for drum transport or storage, field personnel are responsible for ensuring that the empty drums are placed on pallets before they are filled and that the lids are sealed on with the bolt-tighten ring after the drums are filled. Because the weight of one drum can exceed 500 pounds, under no circumstances should personnel attempt to move the drums by hand. Nor should personnel operate forklifts as part of their regular field activities. Removal of drums to the staging area is normally the responsibility of the client, unless other arrangements have been made.

3.3. Drum Labeling

Each drum that is used will be assigned a unique number which will remain with that drum for the life of the drum. This number will be written in permanent marker on the drum itself; do not label drum lids. Drum labels will contain the following information:

- 1. waste accumulation start date
- 2. well number or boring number, if applicable
- 3. drum number
- 4. contents matrix (soil, water, slurry, etc.)
- 5. EPA project name

3.4 Waste Disposal

Responsibility for the final disposal of investigation derived-waste will be determined before field activities are begun and will be described in the investigation work plan. Disposal or long-term storage (over 90 days) of RCRA-designated hazardous wastes requires procedures which are beyond the scope of this SOP.

SAMPLE IDENTIFICATION AND FIELD RECORDS

1.0 INTRODUCTION

Sample identification, chain-of-custody records, receipt for sample forms, and field records (with the exception of surveying notes) should be recorded with waterproof, non-erasable ink. If errors are made in any of these documents, corrections should be made by crossing a single line through the error and entering the correct information. All corrections should be initialed and dated. If possible, all corrections should be made by the individual making the error. If information is entered onto sample tags, logbooks, or sample containers using stick-on labels, the labels should not be capable of being removed without leaving obvious indications of the attempt. Labels should never be placed over previously recorded information. Corrections to information recorded on stick on labels should be made as stated above.

Following are definitions of terms used in this SOP:

Project Leader: The individual with overall responsibility for conducting a specific field investigation in accordance with this SOP.

Field Sample Custodian: Individual responsible for maintaining custody of the samples and completing the sample tags and Chain-of-Custody Record.

Sample Team Leader: An individual designated by the project leader to be present during and responsible for all activities related to the collection of samples by a specific sampling team.

Sampler: The individual responsible for the actual collection of a sample.

Transferee: Any individual who receives custody of samples subsequent to release by the field sample custodian.

Laboratory Sample Custodian: Individual responsible for accepting custody of samples from the field sample custodian or a transferee.

One individual may fulfill more than one of the roles described above.

2.0 SAMPLE AND EVIDENCE IDENTIFICATION

2.1 Sample Identification

The method of sample identification used depends on the type of sample collected. *In-situ* field samples are those collected for specific field analysis or measurement where the data are recorded directly in bound field logbooks or on the Chain-of-Custody Record, with identifying information, while in the custody of the sampling team. Examples of such *in-situ* field measurements and analyses include pH, temperature, dissolved oxygen, and conductivity. Samples other than those collected for *in-situ* analysis are identified by using a standard sample tag which are attached to the sample container. In some cases, particularly with biological samples, the sample tag may have to be included with or wrapped around the sample. Sample tags are sequentially numbered and are accountable documents after they

are completed and attached to a sample or other physical evidence. The following information shall be included on the sample tag using waterproof, non-erasable ink:

- project number;
- field identification or sample station number;
- date and time of sample collection;
- designation of the sample as a grab or composite;
- a very brief description of the sampling location;
- the identification of either the sampler(s) or the designated sampling team leader and the field sample custodian (if appropriate);
- whether the sample is preserved or unpreserved:
- the general types of analyses to be performed (checked on front of tag); and
- relevant comments (such as readily detectable or identifiable odor, color, or known toxic properties).

If a sample is split with a facility, state regulatory agency, or other party representative, the recipient should be provided (if enough sample is available) with an equal weight or volume of sample.

2.2 Photograph, Digital Still Image, and Video Identification

2.2.1 Photographs and Digital Still Images

When photographs or digital images are taken, a record of each exposure or image shall be kept in a bound field logbook. The following information shall be recorded in the logbook:

- an accurate description of what the photograph or image shows, including the name of the facility
 or site and the specific project name and project number;
- the date and time that the photograph or image was taken; and
- the name of the individual who took the photograph or digital image.

When photographs are used in technical reports or placed in the official files, the film shall be developed with the negatives supplied uncut. The identifying information that was recorded in the field logbook shall be entered on the back of the prints. For criminal investigations, the negatives must be maintained with the bound field logbook in the project file and stored in a secured file cabinet.

When digital images are used in technical reports or placed in the official files, the disk with the original, unaltered file of the images or a printed copy of the unaltered images shall be placed in the official files, as well. If printed copies of the images are used, each image shall be identified using the information that was recorded in the field logbook.

2.2.2 Video

When a video tape is made the following information should be recorded in a bound field logbook:

- the date and time that the video was recorded;.
- a brief description of the subject of the video tape; and
- · the person recording the video.

Video records shall include a visual notation (placard) at the beginning of the video with the appropriate information (i.e., location, date, time). An audio record may also be included in the video tape with the above logistical information as well as a narrated description of the video record.

A label shall be placed on the video tape with the appropriate identifying information (i.e., project name, project number, date, location etc.). In the event testimony regarding a video tape recording is required for an enforcement case, one individual should be responsible for recording the video for each case. The original, unaltered tape shall be placed in the files.

2.3 Identification of Physical Evidence

Physical evidence, other than samples, shall be identified by using a sample tag or recording the necessary information on the evidence. When samples are collected from vessels or containers which can be moved (drums for example), the vessel or container should be marked with the field identification or sample station number for future identification, when necessary. The vessel or container may be labeled with an indelible marker (e.g., paint stick or spray paint). The vessel or container need not be marked if it already has a unique marking or serial number; however, these numbers shall be recorded in the bound field logbooks. In addition, it is suggested that photographs of any physical evidence (markings, etc.) be taken and the necessary information recorded in the field logbook.

Occasionally, it is necessary to obtain recorder and/or instrument charts from facility-owned analytical equipment, flow recorders, etc., during field investigations and inspections. Mark the charts and write the following information on these charts while they are still in the instrument or recorder:

- Starting and ending time(s) and date(s) for the chart.
- An instantaneous measurement of the media being measured by the recorder shall be taken and entered at the appropriate location on the chart along with the date and time of the measurement.
- A description of the location being monitored and other information required to interpret the data such as type of flow device, chart units, factors, etc.

After the chart has been removed, the field investigator shall indicate on the chart who the chart (or copy of the chart) was received from and enter the date and time, as well as the investigator's initials.

2.4 Buckets

A plastic bucket can be used to collect samples for *in-situ* analyses, e.g., pH, temperature, and conductivity. However, the bucket should be rinsed twice with the sample water prior to collection of the sample.

3.0 FIELD RECORDS

Each project should have a dedicated logbook. The project leader's name, the sample team leader's name (if appropriate), the project name and location, and the project number should be entered on the

inside of the front cover of the logbook. It is recommended that each page in the logbook be numbered and dated. The entries should be legible and contain accurate and inclusive documentation of an individual's project activities. At the end of all entries for each day, or at the end of a particular event, if appropriate, the investigator should draw a diagonal line and initial indicating the conclusion of the entry. Since field records are the basis for later written reports, language should be objective, factual, and free of personal feelings or other terminology which might prove inappropriate. Once completed, these field logbooks become accountable documents and must be maintained as part of the official project files. All aspects of sample collection and handling, as well as visual observations, shall be documented in the field logbooks. The following is a list of information that should be included in the logbook:

- sample collection equipment (where appropriate);
- field analytical equipment, and equipment utilized to make physical measurements shall be identified;
- calculations, results, and calibration data for field sampling, field analytical, and field physical measurement equipment;
- property numbers of any sampling equipment used, if available;
- sampling station identification;
- time of sample collection;
- description of the sample location;
- description of the sample;
- who collected the sample;
- how the sample was collected;
- diagrams of processes;
- maps/sketches of sampling locations; and
- weather conditions that may affect the sample (e.g., rain, extreme heat or cold, wind, etc.)



22 SOUTH LINDEN STREET
DUQUESNE, PA 15110
(412) 469-9331
FAX (412) 469-9336
WWW.KURESOURCES.COM

May 24, 2012

Mr. Michael Watson
Environmental Cleanup Program
Pennsylvania Department of Environmental Protection
Southwest Region
400 Waterfront Drive
Pittsburgh, PA 15222-4745

Subject:

Cleanup Plan Addendum

The Industrial Center of McKeesport

McKeesport, Pennsylvania

Dear Mr. Watson:

KU Resources, Inc. (KU Resources) is submitting this Cleanup Plan Addendum Letter for the Industrial Center of McKeesport property on behalf of Regional Industrial Development Corporation of Southwestern Pennsylvania (RIDC) in regards to our March 15, 2012 meeting. Please see the changes below in regards to the Cleanup Plan from June of 2000.

The June 2000 Cleanup Plan (Attachment 1) stated the following: "Cover types include asphalt or concrete paving (for parking areas and roadways) and soil (for landscaped and grass areas). If soil is used as a cover material, it will consist of 0.5 feet of clean fill, capable of sustaining vegetation."

These two sentences should be amended as follows: "Cover types include asphalt or concrete paving (for parking areas and roadways) and soil, crushed concrete, crushed brick, or stone (for remaining areas). If soil, crushed concrete, crushed brick, or stone is used as cover material, it will consist of 0.5 feet of clean fill."

The soil cover pathway elimination process will be maintained into the future through the use of a site-wide Operations and Maintenance (O&M) Plan. In the event of a sale of property, the deed transferring this property will define the implementation and maintenance pursuant to the O&M Plan as a responsibility of the purchaser. A copy of the 2000 O&M Plan for the Industrial Center of McKeesport is provided as Attachment 2. The Approved Soil Management Plan will be utilized for future earth moving activities on the Site (Attachment 3). A drawing depicting the cover areas of the Site is included as Attachment 4.

Mr. Michael Watson May 24, 2012 Page 2

Should you have any questions or require additional information, please feel free to contact me at (412) 469-9331.

Sincerely,

Sara B. Uhl

Project Scientist II

SBU:cak

Attachments

cc: D. Sharek (RIDC)



SUPPLEMENTAL ADDENDUM

REMEDIAL INVESTIGATION
BASELINE RISK ASSESSMENT
CLEANUP PLAN
SITE-SPECIFIC STANDARD
INDUSTRIAL CENTER OF MCKEESPORT
MCKEESPORT, PENNSYLVANIA
LPR No. 5-2-112-8837

Prepared for:

Regional Industrial Development Corporation of Southwestern
Pennsylvania
Suite 500
425 Sixth Avenue
Pittsburgh, PA 15219

And

RIDC Southwestern Pennsylvania Growth Fund Suite 500 425 Sixth Avenue Pittsburgh, PA 15219

Prepared by:

KU Resources, Inc. Business Innovation Center Suite 207 One Library Place Duquesne, PA 15110

January 2001

Supplemental Addendum to Remedial Investigation, Baseline Risk Assessment Cleanup Plan Site Specific Standard Industrial Center of McKeesport McKeesport, Pennsylvania LRP No. 5-2-112-8837

January 2000

KU Resources, Inc. (KU Resources) has received the Pennsylvania Department of Environmental Protection (PADEP) letter, dated September 15, 2000, providing comments on the above referenced report. KU Resources offers the following responses to the comments and provides this document as a supplemental addendum to the Remedial Investigation, Baseline Risk Assessment Cleanup Plan, submitted to PADEP in June, 2000.

1. Lead, Cadmium, Mercury, Benzo (b, k) Fluoroanthene, Methylene Chloride have been found in onsite soils exceeding the Act 2 soil to groundwater MSCs and Iron, Lead and Vanadium have been found exceeding the direct contact MSCs. Please evaluate these exceedances accordingly. Section 250.405 of the Act 2 regulations specifies that Site Specific Standards be developed based on a risk assessment unless fate and transport analysis demonstrates that neither present nor future exposure pathways exists or "...if the Department, in its remedial investigation report or cleanup plan approval, determines that a specific remediation measure that eliminates all pathways, other than a no-action remedial alternative, can be implemented to attain a site specific standard in accordance with the requirements of attainment demonstration as specified in Subchapter G (relating to demonstration of attainment)."

Response: Based on our discussions with you regarding this comment, we have prepared an alternative evaluation, which is summarized in the attached Table 1. The table uses the groundwater MSC and Soil to Groundwater Pathway (STGP) Numeric Values provided by the Pennsylvania Land Recycling Act (Act 2) Rules and Regulations to estimate a ratio based on the PADEP Model presented in Section 250.308(a). The ratio was then used, along with maximum soil concentrations observed at the site, to develop assumed groundwater concentrations. Using the groundwater to surface water flow ratio, found in Appendix M of the June 2000 Remedial Investigation Baseline Risk Assessment Cleanup Plan, an in-stream concentration was calculated for each constituent. This value was then compared to regulatory limits obtained from Title 25, Chapter 16, Appendix A, Table 1. The predicted concentrations within the Monongahela River are well below the PADEP established values.

2. Section 8 (Cleanup Plan) of this document provides a brief discussion of paving and soil covers to be used that"... have or will eliminate the direct contact pathway in accordance with the Act 2 requirements." Please provide a detailed map in plan view identifying the specific areas that have and will be soil covered and paved to demonstrate pathway elimination.

Response: Figure 1, attached, shows the areas that are currently covered with existing building footprints, paving, and landscaping. For the areas not currently developed, the exact location of similar features will be dependent upon future construction considerations. We have noted these areas on Figure 1 as "Proposed Future Development with Buildings, Paved Areas, and Soil



Covers on Property." Note that any Final Report for any of these areas will have to demonstrate the implementation of the designated pathway elimination measures.

 Evaluation of the water quality and the groundwater/surface water hydraulic relationship for Crooked Run culvert identified in the eastern section of the site is not provided in this report. Characterization of this feature is necessary for approval of the Remedial Investigation Report.

Response: Analytical results for groundwater samples obtained from the monitoring wells located in the vicinity of Crooked Creek culvert (MW-5 and MW-18), including results from the previous investigations, have consistently been reported at concentrations below detection limits for organic constituents. Inorganic constituents have also been reported at concentrations below detection levels, or below PADEP MSCs. Additionally, the organic constituent concentrations for sampling conducted in the vicinity of the culvert have exhibited a decrease with depth, which would indicate no migration of constituents of interest resulting in unacceptable impacts, even if access to Crooked Run existed.

Historical documentation shows that the Crooked Run culvert was a reinforced concrete sewer pipe put in place when the fill/slag material was placed on the McKeesport site. Currently any water flowing through the culvert is surface water/storm water flow from offsite, and comes in little contact with groundwater flowing across the site. This is evidenced by water levels obtained by KU Resources during the Remedial Investigation. The groundwater level in this area is not abnormally high (which would be suggestive of a discharge of water from the culvert to the surrounding soil), nor abnormally low (which would be suggestive of a discharge of groundwater into the culvert). Further, the water table gradient in the area of the culvert is similar to that of other areas of the Industrial Center of McKeesport property. Figures 4-1 and 4-2 located in the investigation report show the water levels and hydraulic gradient across the site. Copies of pertinent excerpts from the Remedial Investigation report are provided for convenience in Appendix A.

4. A "blue sand material" was identified in Boring B-2 and B-3 throughout the 0-11 foot interval. The source of the material is not provided in the report. Characterization of this material is necessary for approval of the Remedial Investigation Report.

Response: The site is underlain by approximately 35 feet of fill material comprised mainly of poorly sorted slag ranging to cobble size. The DLA report (1988), ICF Kaiser report (1993), and KU Resources' field activities are all consistent in this interpretation.

KU Resources believes the blue sand encountered is fill material. During the Remedial Investigation, KU Resources submitted the 2- to 5-foot sampling interval for soil borings B2 and B3 for laboratory analysis. Additionally, the 0- to 0.5-foot sampling interval for soil boring B3 was



Supplemental Addendum to Remedial Investigation, Baseline Risk Assessment Cleanup Plan Site Specific Standard Industrial Center of McKeesport McKeesport, Pennsylvania LRP No. 5-2-112-8837 January 2000

submitted for laboratory analysis. Analytical results for these samples were below soil MSCs, and were not indicative of any kind of chemical source associated with the blue sand materials. Boring logs for borings B2 and B3, and the analytical summary tables associated with the soil samples obtained from these borings are attached. Copies of pertinent excerpts from the Remedial Investigation report are provided for convenience in Appendix B.

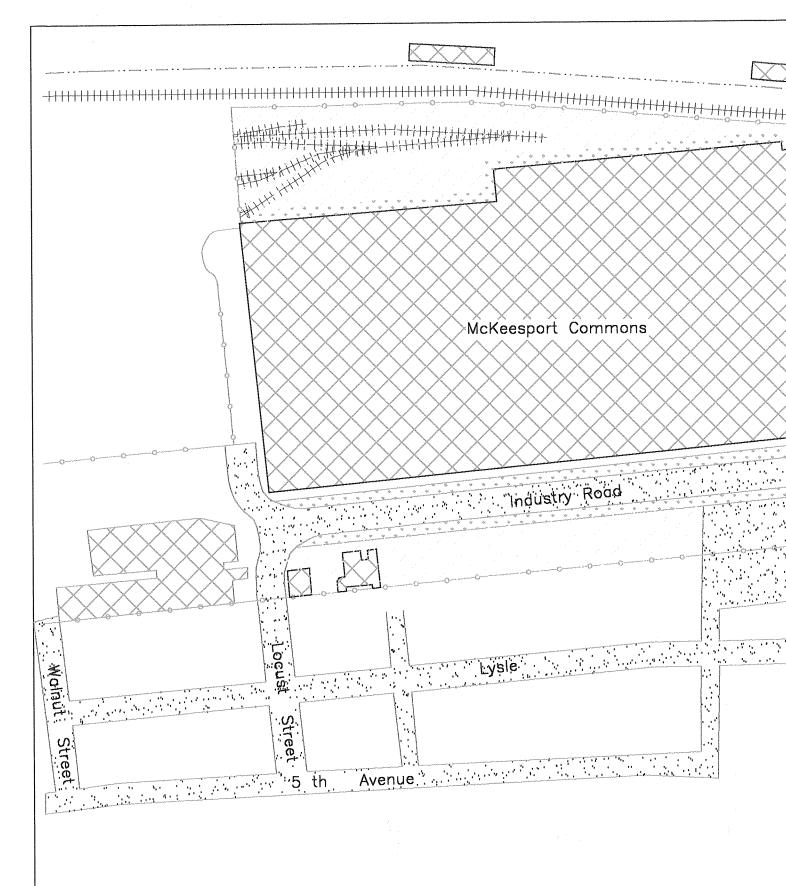
5. Tetrachloroethene (PCE) has been detected in the groundwater at MW-19 at concentrations exceeding the non-residential MSC. Monitoring well MW-19 is characterized as an upgradient well; however, an explanation for the source of this contamination is not provided. Please provide information/data that a source area for this contamination does not exist on the Industrial Center of McKeesport property.

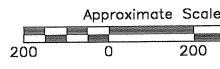
Response: Elevated concentrations of Tetrachloroethene (PCE) were observed in samples obtained by ICF Kaiser in the 1993 groundwater investigation and in the first round of sampling during the remedial investigation. However, the second sample obtained during the remedial investigation showed the concentration as being below maximum contaminant levels, continuing a trend of decreasing concentrations.

Historical documentation reviewed and presented by ICF Kaiser in the 1993 report stated that the source of PCE was from a location upgradient of the Industrial Center of McKeesport property. KU Resources searched Sandborn fire insurance maps to determine if there was an upgradient source of the PCE. KU Resources observed two potential source locations within two blocks of the McKeesport site. A dry cleaning establishment was observed upgradient of monitoring well MW-19, and approximately two blocks to the south along 4th Avenue. The dry cleaning facility was in business beginning in 1953 and was still in business in the 1970's. Additionally, there was a tire/automotive garage located immediately adjacent to the McKeesport site guard house on Locust Street. KU Resources believes this additional data confirms what ICF Kaiser interpreted in 1993. The Sanborn fire insurance maps depicting these two potential source locations are included as Appendix C. Additionally, Figure 4-2 of the Remedial Investigation Report (KU Resources, Inc., June 2000) shows the groundwater flow direction as being distinctly toward the Monongahela River, from both of the upgradient locations and across the McKeesport site property.

Also included in this supplemental addendum are the pictures which were taken of the shoreline along the property. None of the pictures indicate ongoing environmental impacts.







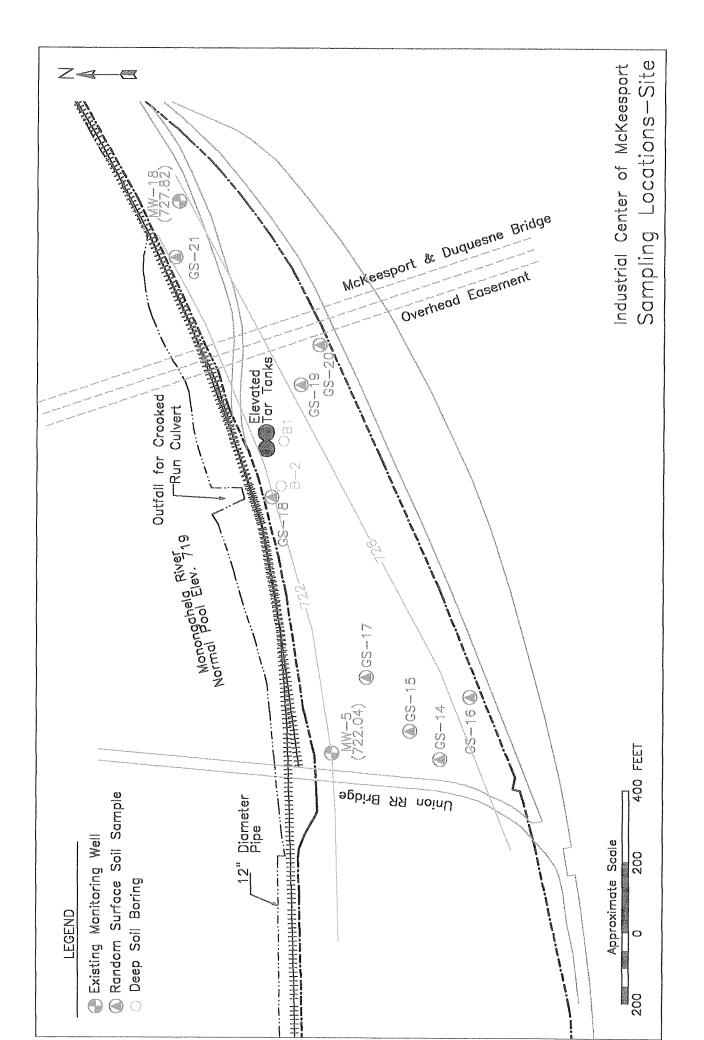


Table 1 Impacts on the Monongahela River from Constituents that Exceed the Soil to Groundwater Pathway Numeric Values

Industrial Center of the City of McKeesport
McKeesport, Allegheny County, Pennsylvania

Parameters	Groundwater	Soil to Groundwater	Ratio Based on	Maximum	Assumed Groundwater	Assumed
	MSC ⁽¹⁾ (ug/l)	Pathway Numeric	PADEP Model ⁽³⁾	Concentration in	Concentration(5) (ug/l)	Groundwater
	, ,	Values ⁽²⁾ (mg/kg)		(4)	, ,	Concentration (mg/l)
	(MSC)	(STGP)	(R ₁ = MSC/STGP)	(Sm)	$(GW = Sm \times R_1)$	(GW/1000)
INORGANICS						
Cadmium	5	38	1.32E-01	3.88E+01	5.11E+00	5.11E-03
Lead	5	450	1.11E-02	4.32E+03	4.80E+01	4.80E-02
Mercury	2	10	2.00E-01	3.56E+01	7.12E+00	7.12E-03
ORGANICS						
Benzo(b)Fluoroanthene	1.2	160	7.50E-03	1.77E+02	1.33E+00	1.33E-03
Benzo(k)Fluoroanthene	0.55	600	9.17E-04	1.77E+02	1.62E-01	1.62E-04
Methylene Chloride	3	0.038	7.89E+01	1.13E+00	8.92E+01	8.92E-02

Parameters	Assumed	Carcinogen	Groundwater /	Calculated	Regulatory Limit (8)	Exceedance Yes/No
<u> </u>	Groundwater	(yes/no)	Surface Water Flow	Instream		
	Concentration ⁽⁶⁾		Ratio (7)	Concentration		
	(mg/l)			(mg/l)		
	(GW)		(R_2)	$(SW = GW \times R_2)$		
INORGANICS						
Cadmium	5.11E-03	yes	6.03E-05	3.08E-07	1.00E-02	no
Lead	4.80E-02	no	1.65E-05	7.92E-07	5.00E-02	no
Mercury	7.12E-03	no	1.65E-05	1.17E-07	1.44E-04	no
ORGANICS						
Benzo(b)Fluoroanthene	1.33E-03	yes	6.03E-05	8.00E-08	3.00E-06	no
Benzo(k)Fluoroanthene	1.62E-04	yes	6.03E-05	9.78E-09	3.00E-06	no
Methylene Chloride	8.92E-02	yes	6.03E-05	5.38E-06	5.00E-03	no

- (1) Medium Specific Concentrations for regulated Substances in Groundwater as presented in the Pennsylvania Land Recycling Act (Act 2) Rules and Regulations, Appendix A, Tables 1 and 2.
- (2) Medium Specific Concentrations for Regulated Substances in Soil (Soil to Groundwater Numeric Values) as presented in the Act 2 Rules and Regulations, Appendix A, Tables 3 and 4.
- (3) The organic and inorganic models used by the Pennsylvania PADEP to estimate the impacts of soil constituents on groundwater are presented in section 250.308 (a). Both the organic and inorganic models consist of linear equations which utilizes very conservative assumptions to establish soil concentration limits which are protective of groundwater quality. Because the equations are linear, and only two variables are present for each parameter (soil concentration and groundwater concentration), a ratio between the soil and groundwater concentrations exists for each parameter which can be used to calculate one concentration, given the other.
- (4) The Maximum Soil Concentration as indicated on Tables 4-1, 4-2, 4-3, 4-4, and 4-5 of the June 2000 Remedial Investigation Baseline Risk Assessment Cleanup Plan for the Subject Property
- (5) The Anticipated Groundwater Concentration is calculated by multiplying the maximum soil concentration observed in soil at the property by the ratio inherent in the PADEP model.
- (6) The concentrations calculated in the upper section of this table
- (7) This ratio of groundwater flow into the Monongahela River to surface water flow within the Monongahela River was previously calculated in Appendix M of the June 2000 Remedial Investigation Baseline Risk Assessment Cleanup Plan for the subject property.
- (8) Listed in Title 25, Chapter 16, Appendix A, Table 1.



Page 2 of 3

NOTE: Shaded values exceed PA Act 2 MSCs for either the direct contact or soil-to-groundwater pathways.

TABLE 4-4
INDUSTRIAL CENTER OF MCKEESPORT
RANDOM SURFACE SOIL SAMPLES
INORGANIC AND SEMIVOLATILE ORGANIC CONSTITUENTS IN SOILS

Constituents	GS-15	GS-18	GS-17	GS-18	G-18 Duplicate	SS-19	06:35	8
INORGANICS (mg/kg)							07-00	17-50
Aluminum	5,050	14,700	8.160	11.200	000 AF	9	9	1
Antimony	<0.25	<0.25	<0.25	<0.25	080	000,01	000, F	23,500
Arsenic	0.27	<0.25	0.59	<0.25	0.52	0.36	0.7.0	0.28
Barium	199	331	215	282	276	38.6	27.0	1.37
Beryllium	0.52	0.69	0.56	0.57	0.71	0 0	770	340
Cadmium	1.9	<0.5	3.2	2		000	0.04	S. S.
Calcium	22,600	79,600	65,500	93,900	000.66	143 000	0.5	8. 6
Chromium	23.4	15.5	816	57.4	63.7	58.8	33.7	130,000
Copali	1.06	0.41	0.75	0.79	0.86	0.82	2.05	, K
laddon laddon	50.7	46.2	88.3	61.5	85.0	70.9	40.0	0 6
5 6	26,500	37,900	44,000	26,000	27,200	20,500	18,700	11 900
	144	75.4	0750	665,47,539	507.70	132	142	132
	3,750	12,300	10,600	17,500	18,000	25,500	8,640	25.600
	2,850	3,180	4,970	4,230	4,170	4,430	3,130	2840
Nichol	1.56	<0.05	0.11	0.24	0.29	0.45	0.12	22.0
	23.1	13.8	63.7	20.7	14.1	10.5	12.9	30.6
	295	778	343	729	840	1,860	800	2020
TO TO TO TO TO TO TO TO TO TO TO TO TO T	<0.25	<0.25	0.39	<0.25	<0.25	<0.25	0.29	0.72
	40.5	40.5	<0.5	<0.5	<0.5	<0.5	<0.5	40.5
The	140	372	209	463	532	621	322	1 050
	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
727	14.0	22.4	264	41.6	51.7	41.6	25.3	14.0
1 C	503	107	157	195	144	444	249	0 0
SEMIVOLATILE ORGANICS (µg/kg)	0.833	<0.05	0.075	0.35	0.075	0.442	0.083	0.083
ne	×10	0.5 V	V 410	100	, c			
Anthracene	×10	۸ ۲۵	V 10	, v	2 6	2 (v	×10
Benzidine	×10	×10	×10	V	6,44	017	0 V	×10
Benzo(a)anthracene	×10	7,100	, V	, v	0 0	017	v. 0	×10
Chrysene	ot>	×10	1.300	V	7 1	0 0	v 10	410
Fluoranthene	5,800	13,900	29,000	410	24 700	017	015	v10
Phenanthrene	V 10	<10	<10	×10	2.180	V V	03,20	o ç
(Pyrene	<10	<10	<10	<10	20,000	410	, v	2 0
								2

TABLE 4-5 (a)
INDUSTRIAL CENTER OF MCKEESPORT
POTENTIAL DISCRETE SOURCE AREAS
INORGANIC CONSTITUENTS IN SOILS

	Boring B-1	Boring B-1	Boring B-1	Boring B-2C	Boring B-2C	Boring B-3A	Boring B-3B	Roring B.3C
Constituent (mg/kg)	00.5	2'-5'	20'-22'	25	15'-16.5'	00.5	2.4.	15'-20'

Aluminum	8,210	8,680	22,900	17,800	20,900	6,230	8.230	13.900
Antimony	0.95	1.38	0.39	<0.25	<0.25	0.75	0.95	<0.05 <0.05
Arsenic	1.07	2.2	1.31	1.27	0.36	1.51	1.29	08.0
Barium	115	170	250	184	191	94.9	97.3	247
Beryllium	0.94	1.97	4.89	0.32	<0.25	4	1.67	, c
Cadmium	<0.5	1.3	<0.5	<0.5	<0.5	<0.5	<0.5	\$0.5
Calcium	124,000	68,700	116,000	97,600	151,000	20,500	27,700	75,900
Chromium	197	35.5	14.6	6.3	9.0	11.3	2.8	15.4
Cobalt	0.29	0.42	3.16	0.58	<0.25	1.26	0.89	0.4
Copper	13.6	102	17.1	17.3	<0.5	76.1	114	12
Iron	20,000	31,300	11,200	090'2	3,450	44.700	43.700	9 450
Lead	20.7	212	149	38.5	<0.5	70	48.1	3 7 3
Magnesium	35,800	13,600	13,900	12,500	6,680	3,140	4.100	6.280
Manganese	6,130	2,250	2,400	1,530	1,680	1,240	1,030	1,540
Mercury	0.13	1.55	<0.05	<0.05	<0.05	<0.05	<0.05	200
Nickel	7.5	12.4	2.5	3.4	0.8	11.3	4.9	7.5
Potassium	341	36.8	1,150	920	869	565	747	753
Selenium	0.66	0.57	1.59	<0.25	<0.25	<0.25	<0.25	<0.25
Silver	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Sodium	288	397	719	457	585	160	224	378
Thallium	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
Vanadium	311	36.8	30.5	10.1	8.5	12	10.7	16.2
Zinc	224	150	31.7	44	1.3	117	102	27.9
Cyanide	0.200	1.06	3.52	1.19	0.333	0.858	<0.05	1.47

TABLE 4-5 (b)
INDUSTRIAL CENTER OF MCKEESPORT
POTENTIAL DISCRETE SOURCE AREAS
ORGANIC CONSTITUENTS IN SOILS

Constituent (ug/kg)	Boring B-1 0'-0.5'	Boring B-1 2'-5'	Boring B-1 20'-22'	Boring B-2C 2'-5'	Boring B-2C 15'-16,5'	Boring B-3A	Boring B-3B	Boring B-3C
Volatile Organics								07- 61
Benzene	\$	17	< <u>~</u>	\$V	\ \	ц		•
n-Butylbenzene	\$	\$	\$	\$, v	\$ \$		S S
sec-butyloenzene	ςς '	7.5	\$ \$	\$	\$	\ \ \		γ ·
lei i-butyibenzene	\$	14.7	\$	\$	\$	× ×		? \
4-Ciliorolouene	\$	<5	<5	<5	\$	\$ 2	, _v	? '
1, x-Old Indianated	\$	11.4	\$	\$>	<5>	<5>		2
-,3-Dicilocoenzene	<u>S</u> '	20	\$	\$	V	\$		7 4
Curybenzene	\$	23.6	27.3	6.09	\$	46.3	2 4	? \
Sopiopyloenzene	v '	17	\$	\$	\$. V	2	? \
Moth despropried	\$	8.7	<5	\$	~	ν Υ	3 4	7 4
Noohholoo	χ	\$	\$	\$>	<5	<5>	2	0
l'aprillaiene	Ω '	335	159	188	221	121	4 0	7 4
nFlopyipenzene	ςς •	18.2	\$	\$	\$ \$, V	יי פי	γ ·
otyrene 1 1 2 2 3 4 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2	\$	\$	\$	\$, Ç) ₁ C	7 4	\$
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l etrachloroethene	\$>	\$>	\$	\$	2	2 4	Ç	<5>
Toluene	\$	79.5	128	562	7 4	7 6	\$ 2	\$
Trichlorofluoromethane	\$	\$	\$ V	210	7 5	0.00	38	<2
1,2,4-Trimethylbenzene	12.7	82.2	, ₁	252	2 6	v i	\$	×10
1,3,5-Trimethylbenzene	\$	G	<u>۸</u>	4 4	0.122	147	38.8	\$>
m-,p-Xylene	\$	48.1	0 90	7 9	Cy Cy	86.7	16.3	\$
o-Xylene	7.2	07.5	70.40	2 3	58.7	71.2	31.8	<5>
	!	3	70.8	141	123	83.5	38.8	\$
Semivolatile Organics	***************************************	97.70			*******	- 2,-11		•
Acenaphthene	×10	200	×10	<10	×10	2,	(
Acenaphthylene	<10	200	V > 10	V V	0,4	7 1	012	×10
Anthracene	<10	6200	<10	V10	0 0	0,7	012	×10
Benzidine	<10	35400	× ×		7 1	017	×10	320
Benzo(a)anthracene	×10	8100	V V	, ,	7 1	010	×10	×10
Benzo(b,k)fluoranthene	<10	37500	120	2 0	0 0	012	<10	×10
bis (2-Chloroethoxy) methane	×10	×10	01.5	7 1	7 7	01.>	×10	<10
bis (2-Ethylhexyl) phthalate	<10	5000	00800	0 0	01.5	< 10	<10	× × 10
Butyl benzyl phthalate	<10	×10		7 7	01.7	× 10	<10	× × 10
Chrysene	<10	×10	, V		010	480	×10	×10
3,3'Dichlorobenzidine	<10	V	2 0	2 3	0.0	V 10	× 10	× × × × × × × × × × × × × × × × × × ×
2,6-Dinitrotoluene	<!--</td--><td>5200</td><td>2 0</td><td></td><td>01></td><td>390</td><td>× × 10</td><td><10</td>	5200	2 0		01>	390	× × 10	<10
Di-n-butyl phthalate	01.>	240		012	<10	<10	× 10	. <10
Di-n-octyl phthalate	×10	2.7	07.6	01.7	o.v	~ 10	<10	<10
Fluoranthene	2950	124000	320	010	- v	×10	×10	×10
Fluorene	×10	1800	2 0	010	v 10	×10	<10	0880
N-Nitrosodiphenylamine	V V	000	2 7	V	<u><10</u>	<10	× 10	×10
Phenanthrene	000	2000	015	ot>	<10	×10	×10	V V
Pyrene	3820	0007	0.7	×10	ot>	<10	<10	110
4-Nitrophenol	V V		0.7	01v	× 10	×10	<10	V V
2,4,6-Trichlorophenol	0, 0	V V	V10	0 v	~ 10	<10	<10	0, 0
		01,	loc)	101>	×10	×10	<10	V V

NOTE: Shaded values exceed PA Act 2 MSCs for either the direct contact or soil-to-groundwater pathways.

TABLE 4-6 INDUSTRIAL CENTER OF MCKEESPORT GROUNDWATER QUALITY DATA SUMMARY

Constituent*	MW-5	MW-5	MW-5	I MW-5	MW-5
	DLA	ICF Kaiser	ICF Kaiser	KU Resources	KU Resources
	Dec-87	Jun-93	Jul-93	Jul-98	Mar-99
INORGANICS/CYANIDE (mg/L)					
pH		6.9		6.65	6.04
TDS					
Aluminum				0.87	0.34
Arsenic, Dissolved		<0.0005		<0.005	<0.005
Antimony					<0.005
Barium, Dissolved	<0.1	<0.10		<0.05	0.01
Beryllium					
Cadmium, Dissolved		0.0021		<0.01	0.0018
Calcium				117	71.6
Chromium, Dissolved	<0.05	0.011	THE STREET, ST	<0.01	<0.001
Cobalt					0.06
Copper, Dissolved		0.03		<0.01	<0.001
Iron, Dissolved	34.5	3.27		1.35	1.94
Lead, Dissolved	0.1	<0.001		<0.01	<0.001
Magnesium, Dissolved		17.9		23.8	14.2
Manganese, Dissolved	15	10.30		8.09	9.75
Mercury, Dissolved	0.001	<0.0002		<0.0005	<0.0005
Nickel	İ			0.04	0.032
Potassium	I			4.12	3.01
Selenium, Dissolved	<0.002	<0.0005		<0.005	<0.005
Silver, Dissolved	<0.01	<0.005		<0.01	<0.0005
Sodium				46.6	3 9.2
Vanadium		1		<0.01	<0.010
Zinc, Dissolved	0.17	0.19		0.15	0.088
Ammonia, Nitrogen	1	0.32		0.26	0.19
Cyanide, Total		<0.001		<0.005	<0.005
VOLATILE ODGANICO (m. ml.)	İ			Ī	
VOLATILE ORGANICS (mg/L)		10.005		10.004	-0.005
Benzene Chloroform		<0.005		<0.001	<0.005
		<0.005		<0.001	<0.005
cis-1,2-Dichloroethene		-0.00		<0.001	<0.005
Naphthalene		<0.02		<0.001	<0.005
Tetrachloroethene	ark, Militar and Militar and American Commission of the Contract of the Contra	<0.005	e (h in disercina anno saosso academical aceste aceste con	<0.001	<0.005
Toluene		<0.005		<0.001	<0.005
Trichloroethene		<0.005		<0.001	<0.005
1,2,4-Trimethylbenzene		ł		<0.001	<0.005
m-,p-Xylene		į		<0.001	<0.005
o-Xylene				<0.001	<0.005
SEMI-VOLATILE ORGANICS (mg/L)					
Acenaphthene		<0.02		<0.002	<0.01
Fluorene		<0.02		<0.002	<0.01
Phenanthrene		<0.02		<0.002	<0.01

TABLE 4-6 INDUSTRIAL CENTER OF MCKEESPORT GROUNDWATER QUALITY DATA SUMMARY

Constituent*	MW-18	MW-18	MW-18	MW-18
	ICF Kaiser	ICF Kaiser	KU Resources	KU Resources
	Jun-93	Jul-93	Jul-98	Mar-99
INORGANICS/CYANIDE (mg/L)				
pH	7.0			6.57
TDS	/.v			0.5
Aluminum			6.09	0.34
Arsenic, Dissolved	<0.0005		<0.005	<0.005
Antimony	10.0000		70.005	<0.005
Barium, Dissolved	<0.10		0.11	0.04
Beryllium	10.10		0.11	<0.00
Cadmium, Dissolved	<0.001		<0.01	<0.000
Calcium	0.001		217	180
Chromium, Dissolved	0.013		<0.01	<0.001
Cobalt		AT BURNEY STATE CONTRACTOR STATE OF STATE AND A SECURITY AND SE		<0.01
Copper, Dissolved	0.01		<0.01	<0.001
Iron, Dissolved	0.1		1.45	0.094
Lead, Dissolved	<0.001		<0.01	<0.001
Magnesium, Dissolved	18.9		42.3	27.3
Manganese, Dissolved	2.89	arrow angan ngoriphapsor are in the of hydrodic propalation party.	0.67	2.75
Mercury, Dissolved	<0.0002		<0.0005	<0.0005
Nickel			<0.01	<0.005
Potassium			6.07	4.94
Selenium, Dissolved	0.0025		<0.005	<0.005
Silver, Dissolved	<0.005		<0.01	<0.0005
Sodium			21.3	18.9
Vanadium			0.02	<0.010
Zinc, Dissolved	0.09		0.04	<0.010
Ammonia, Nitrogen	0.04		<0.10	<0.1
Cyanide, Total	0.008		<0.005	<0.005
VOLATILE ORGANICS (mg/L)				
Benzene	<0.005		<0.001	<0.005
Chloroform	<0.005		<0.001	<0.005
cis-1,2-Dichloroethene			<0.001	<0.005
Naphthalene	<0.01		<0.001	<0.005
Tetrachloroethene	<0.005		<0.001	<0.005
Toluene	<0.005	Andrew Specific Supplier Specific Speci	0.0067	<0.005
Trichloroethene	<0.005	İ	<0.001	<0.005
1,2,4-Trimethylbenzene		1	0.0019	<0.005
m-,p-Xylene			<0.001	<0.005
o-Xylene			<0.001	<0.005
SEMI-VOLATILE ORGANICS (mg/L)		1		
Acenaphthene	<0.01	ĺ	رم مم	-0.04
Fluorene	<0.01	į	<0.002	<0.01
Phenanthrene	<0.01		<0.002 <0.002	<0.01 <0.01

"Note: Only those constituents detected in at least one sampling round at at least one monitoring well are listed. All other constituents analyzed for were nondetect. Blanks indicate "not analyzed."

Site-Specific Standard Report The Industrial Center of McKeesport June 2000

4.1.2.3 ICF Kaiser Soil Assessment Program – Power House/Boiler House Area Three identified areas of interest were evaluated during this program: the Electric Repair. Shop/Power House; the Pipe Storage Building; and the Walker Thickener Area. Additional random sampling was also performed across the study area outside of these areas of interest. All soil samples were collected at a depth of 6 inches below ground surface, because reviews of the area by DLA and ICF Kaiser identified only potential sources of constituents to surface soils.

A full copy of the ICF Kaiser report is included as Appendix C. It should be noted that the conclusions made by ICF Kaiser in this report were based on draft Pennsylvania Act 2 regulations and standards that have since been finalized, with some changes. As a result, the ICF Kaiser conclusions have been updated below.

Analytical results for this investigation are summarized in Tables 4-1(a) through 4-1(d). These Tables also list the Pennsylvania non-residential direct contact and non-residential used aquifer soil-to-groundwater Act 2 standards (Medium Specific Concentrations, or MSCs) for each constituent. Five inorganic constituents (cadmium, iron, lead, mercury, and vanadium) were detected at concentrations exceeding their respective Pennsylvania Act 2 Statewide Health standards in at least one soil sample. These exceedances are also indicated on Tables 4-1(a) through 4-1(d).

No organic constituents were detected at concentrations that exceeded their respective MSCs.

A review of the investigation methodology and results indicates that the ICF Kaiser investigation adequately characterized soil quality in this portion of the Industrial Center of McKeesport for Act 2 purposes. The nature of the potential source areas would lead to soil quality impacts in surface soils, which were sampled extensively in each of the specific areas of interest, as well as through a random sample collection process. None of the findings are suggestive of soil quality impacts at depth.

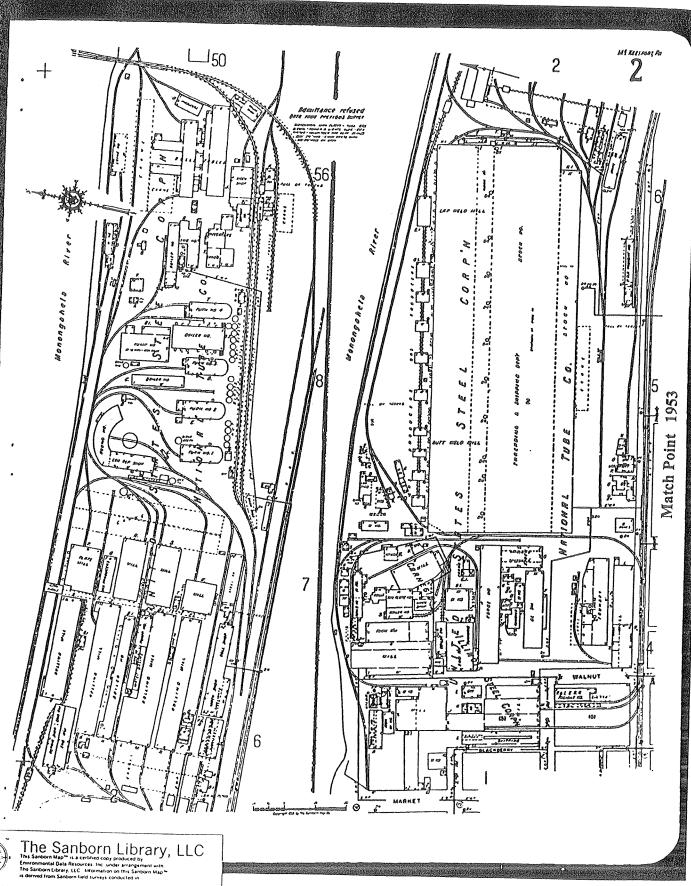
4.2 Results of Current Site Characterization Activities

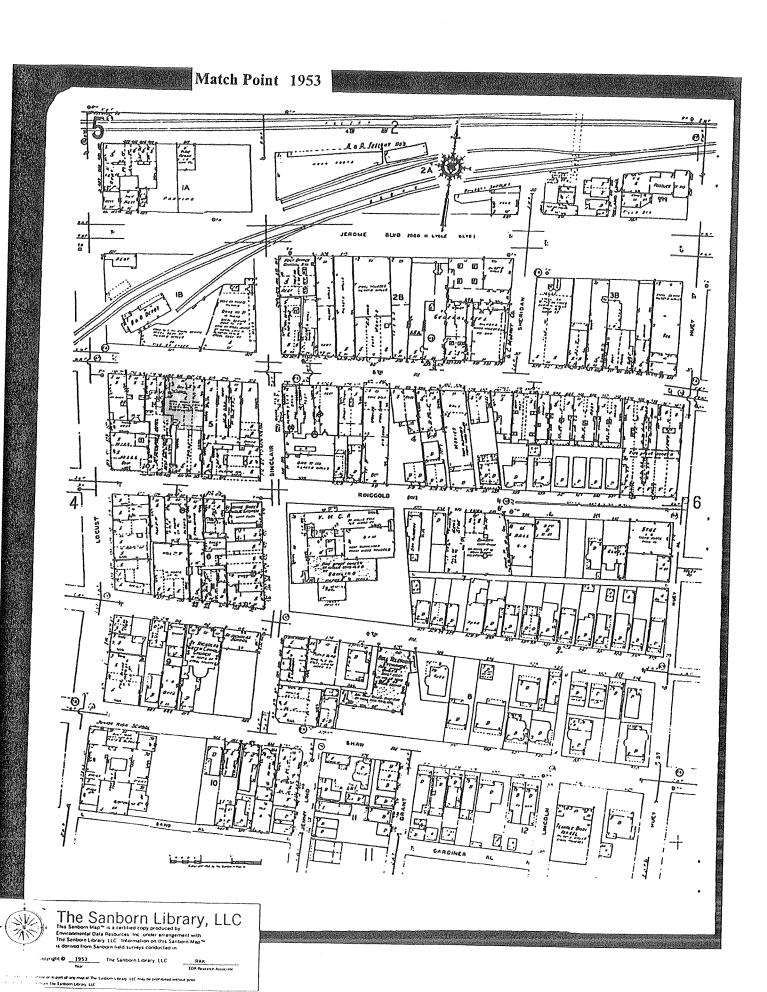
4.2.1 Geology and Hydrogeology

The stratigraphic information collected during the deep soil boring program was consistent with earlier site geologic interpretations. Appendix D includes drilling logs from the newly installed borings, as well as available drilling logs from the previously installed soil borings and monitoring wells. Fill was found to be predominantly slag or a slag soil blend, with minor occurrences of other fill material, such as brick. One notable exception was the occurrence of a hard blue sand material observed throughout the 0-11 foot interval in boring locations B-2 and B-3. The only natural soil encountered in situ was orange brown silt in Boring B-5 at a depth of 18 feet. Saturated materials were encountered at depths ranging from 17 to 27 feet below grade in the soil boring program.

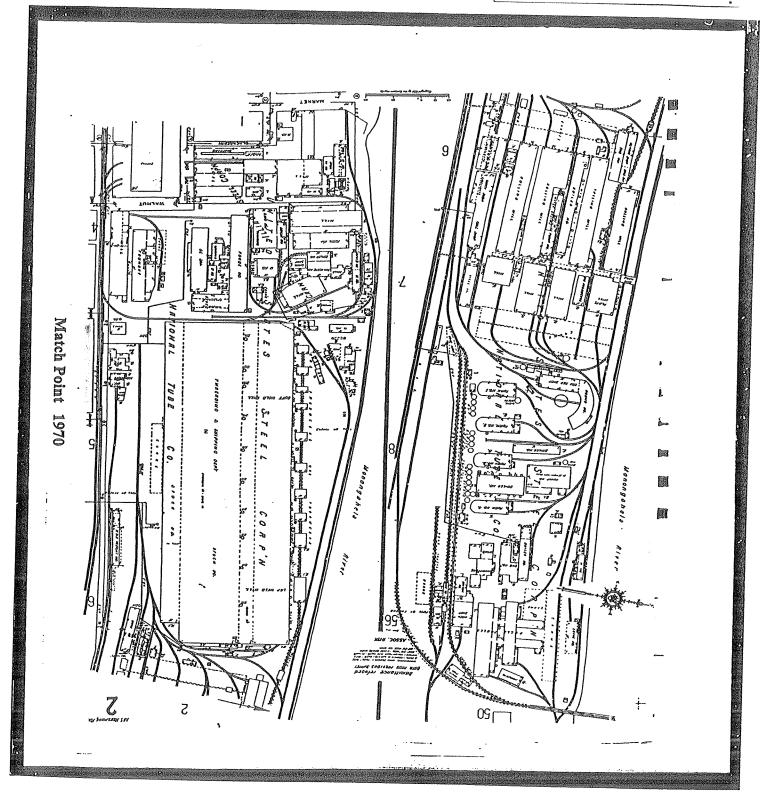
Beneath the Seamless Pipe Mill building, the shallow soil borings encountered primarily slag and sand fill materials. The encountered materials were observed to be very heterogeneous in nature. Numerous initial attempts at soil boring locations encountered refusal, resulting in one or more adjustments to the boring location to allow sampling at the appropriate depth intervals.



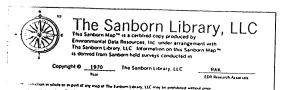




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Match Point 1970





KU Resources, Inc.

Environmental Management Consultants

Project: RIDC

RIDC - McKeesport

McKeesport Commons

Geologist: Von E. Fisher

Driller:

Geo-Environmental Drilling, Inc.

Method: Direct Push

Boring:

B-1 1 of 2

Sheet: Date:

A

05/20/98

Location: Refer to Figure 3-1

Depth (ft)	Lithology	Lithologic Description	Comments	PID	Well Construction
- - 0 -		FILL: sand, slag, cinders, etc.	boring backfilled with bentonite	< 1 ppm	ı
- - - 5				< 1 ppm	
- 10		SAND: Medium Grained, Well to PoorlySorted, Llight Brown		<1 ppm	
-		FILL: Sand, Slag, Etc.		<1 ppm	
— 15 - -				<1 ppm	
20					



KU Resources, Inc.

Environmental Management Consultants

Project:

RIDC - McKeesport

McKeesport Commons

Geologist: Von E. Fisher

Driller:

Geo-Environmental Drilling, Inc.

Method: **Direct Push** Boring:

B-1 2 of 2

Sheet: Date:

05/20/98

Location: Refer to Figure 3-1

S Depth (ft)	Lithology	Lithologic Description	Comments	PID	Well Construction
20		FILL: Sand, Slag, Etc.		3.5 ppm	
			groundwater @ 22-feet		
- 25		BOTTOM OF BORING	Bottom of boring @ 24-feet		
-					
- 30	·				
-					
— 35					
40					



KU Resources, Inc.

Environmental Management Consultants

Project:

RIDC - McKeesport

McKeesport Commons

Geologist: Von E. Fisher

Driller:

Geo-Environmental/Terra Testing Location: Refer to Figure 3-1

Method:

Direct Push/Hollow Stem Auger

Boring:

B-2 1 of 1

Sheet: Date:

05/20/98

	T		T	Т	
Depth (ft)	Lithology	Lithologic Description	Comments	PID	Well Construction
- - o		FILL: slag, cinders, etc.	boring backfilled with bentonite	< 1 ppm	
-		FILL: Blue Sand, Very hard	botting backined with bentonite		
- 5 -			Wet from 5 to 6-feet	< 1 ppm	
		FILL: Blue Sand and Slag, Very Hard		< 1 ppm	
10 					
				<1 ppm	
15 		BOTTOM OF BORING	saturated at 15 feet		
_ _ _ 20					

REMEDIAL INVESTIGATION BASELINE RISK ASSESSMENT CLEANUP PLAN

SITE-SPECIFIC STANDARD

INDUSTRIAL CENTER OF MCKEESPORT MCKEESPORT, PENNSYLVANIA

Prepared for:

Regional Industrial Development Corporation of Southwestern Pennsylvania
Suite 500
425 Sixth Avenue
Pittsburgh, PA 15219

And:

RIDC Southwestern Pennsylvania Growth Fund Suite 500 425 Sixth Avenue Pittsburgh, PA 15219

Prepared by:

KU Resources, Inc.
Business Innovation Center
Suite 207
One Library Place
Duquesne, PA 15110

June 2000

PROFESSIONAL GEOLOGIST CERTIFICATION

I, David R. Kerschner, being a Registered Professional Geologist in the Commonwealth of Pennsylvania, do hereby certify, to the best of my knowledge, information and belief, that the geologic and hydrogeologic information contained in this report, the Site-Specific Standard Report for the Industrial Center of McKeesport, was prepared under my direction and consistent with current professional standards.

Signature

Date

Pennsylvania Registered Professional Geologist 2281-G



EXECUTIVE SUMMARY

The Regional Industrial Development Corporation of Southwestern Pennsylvania, and the RIDC Southwestern Pennsylvania Growth Fund (hereafter collectively referred to as "RIDC"), as the owner of the Industrial Center of McKeesport (formerly the U.S. Steel National Tube Works) in McKeesport, Pennsylvania, is seeking liability protection for the property pursuant to the Pennsylvania Land Recycling and Environmental Remediation Standards Act (Act 2) and its implementing regulations. The subject property is located within a designated Special Industrial Area (SIA). However, RIDC has elected to pursue remediation pursuant to the more protective Site-Specific Standard contained within Act 2, rather than pursue remediation pursuant to the SIA provisions.

The Industrial Center of McKeesport is located along Lysle Boulevard in McKeesport, Pennsylvania. The facility is bordered to the east and west by industrial and commercial properties, to the north by the Monongahela River, and to the south by railroad tracks separating the facility from Lysle Boulevard and the City's main business district. Throughout the 1900s, the National Tube Works produced steel tube and pipe of varying sizes and characteristics. In 1987, the National Tube Works was shut down, and ownership was transferred to Allegheny County in 1989. In 1990, the Allegheny County Industrial Development Authority transferred ownership of the 135-acre site to the RIDC Southwestern Pennsylvania Growth Fund (Growth Fund). In an effort to revitalize the City of McKeesport, create jobs, and promote economic growth, the Growth Fund began preparing the site for redevelopment as an industrial park.

This ongoing effort has included a number of site environmental remediation, demolition, and redevelopment activities. In 1993, the property was designated as a General Industrial District by the City of McKeesport. The subdivided parcels within the Industrial Center of McKeesport are therefore permitted for uses such as manufacturing, printing and publishing, warehouse/storage, vehicle repair, and railroad or truck terminals. Other conditional uses for which the land has been approved include research and development, testing laboratories, and warehouse/storage facilities for hazardous materials.

A scope of work was developed to augment the environmental quality information developed during several previous site characterization activities, and to evaluate the site in the context of the Pennsylvania Land Recycling Program. In March 1998, an Environmental Site Assessment Work Plan for the Act 2 program was submitted to the Pennsylvania Department of Environmental Protection (PADEP) for its review. This Work Plan was approved by PADEP by letter dated April 27, 1998, and was subsequently implemented.

This investigation effort augmented environmental quality data and site physical information that had been previously acquired at the site through the collection and analysis of surface/subsurface soil samples and groundwater samples from across the property, as well as waste and paint samples from discrete areas. Newly acquired site data and physical site information were compiled with the previously-collected information, and compared with Pennsylvania Act 2 Statewide Health Standard Medium Specific Concentrations (MSCs). A conceptual site model was then developed, constituents of concern in soil and groundwater were identified, five



exposure pathways of interest were identified, and pathway elimination approaches were developed to address four of the five identified exposure pathways of interest.

The remaining exposure pathway of interest that could not be addressed by pathway elimination techniques is the groundwater to surface water pathway. A Baseline Risk Assessment conservatively evaluated this pathway pursuant to Act 2 methodology for determining compliance with surface water quality standards from a diffuse groundwater discharge, using "worst-case" factors. This evaluation demonstrated that estimated in-stream (Monongahela River) concentrations are well below the Pennsylvania surface water quality criteria for both aquatic life and for the protection of human health, even using this conservative (protective) approach. Given this outcome, Section 250.309(c)(1) of the Pennsylvania Code states that no action is required to address the groundwater to surface water pathway at the site.

An ecological receptor evaluation was also performed for the site. The evaluation concluded that no ecological receptors exist at the Industrial Center of McKeesport property because there are no potentially viable habitats for ecological receptors due to site development and physical conditions.

The compilation of previous and current site environmental quality and physical information for the Industrial Center of McKeesport demonstrates that a full site characterization has been completed, and that this information is sufficient to evaluate the property pursuant to the Pennsylvania Land Recycling Program. As a result of the findings, RIDC does not intend to eliminate all contamination on the property because the constituents at the site do not prevent occupation of the site based on the intended future uses. Pathways of exposure for future users of the site to remaining site constituents will be eliminated through the implementation of engineering and institutional controls. The site will be reused for office space, laboratory, warehousing and distribution, manufacturing, assembling, testing, servicing, repairing, and research and development purposes. This reuse excludes developing the site or any portion for recreational areas, schools, nursing homes and other residential-style facilities, unless a residential statewide health standard would first be attained at the site.

RIDC is demonstrating attainment of the Site-Specific Standard, using, to a major extent, pathway elimination. The first four of the identified pathways are being, or will be eliminated through the use of waste removal activities, pavement and vegetated soil covers, and formal groundwater use restrictions. The report demonstrates through the use of a highly conservative evaluation that the fifth, the groundwater to surface water pathway, meets Pennsylvania water quality criteria and poses no unacceptable risk to human health and the environment.

The pathway elimination processes currently underway or planned for the Industrial Center of McKeesport include: waste removal; installation of a soil cover (asphalt or concrete paving, and soil); maintenance of the soil cover pathway elimination into the future through the use of a sitewide Operations and Maintenance (O&M) Plan and deed restrictions; management of soils encountered during site development to limit potential impacts to human health and the environment; implementation of groundwater use restrictions via deed restrictions; and the



abandonment of groundwater monitoring wells to facilitate unhindered site development and to eliminate direct pathways to groundwater.

The Act 2 requirements for public notice, public participation, and reporting were followed and documented.



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1.0 INTRODUCTION

The Regional Industrial Development Corporation of Southwestern Pennsylvania, and the RIDC Southwestern Pennsylvania Growth Fund (hereafter collectively referred to as "RIDC"), as the owner of the Industrial Center of McKeesport (formerly the U.S. Steel National Tube Works) in McKeesport, Pennsylvania, is seeking liability protection for the property pursuant to the Pennsylvania Land Recycling and Environmental Remediation Standards Act (Act 2) and its implementing regulations. The subject property is located within a designated Special Industrial Area (SIA). However, RIDC has elected to pursue remediation pursuant to the more protective Site-Specific Standard contained within Act 2, rather than pursue remediation pursuant to the SIA provisions.

To receive the liability protection afforded under Act 2, a final report must be prepared that documents that the property attains one of three established remediation standards (the Background Standard, the Statewide Health Standard, and the Site-Specific Standard), or a combination of the three standards. Under the Site-Specific Standard, a remediator must submit a Remedial Investigation, Baseline Risk Assessment, and Cleanup Plan, as necessary, to support the demonstration of attainment of the standard. Under the Act 2 program, a site characterization must initially be performed. The site characterization identifies and quantifies any conditions that may potentially pose an unacceptable risk to human health or the environment. Once a standard is chosen, the site must be remediated (if necessary) to comply with the selected standard.

This Site-Specific Standard Report describes the subject property and its historical usage, details the site characterization activities, presents physical and chemical site descriptions, describes the selected remediation standard, and documents that the conditions existing at the site, once redevelopment occurs, demonstrate attainment of the Site-Specific Standard for all existing or future exposure pathways anticipated.



2.0 SITE DESCRIPTION

The Industrial Center of McKeesport is located along Lysle Boulevard in McKeesport, Pennsylvania, as shown on Figure 2-1. The facility is bordered to the east and west by industrial and commercial properties, to the north by the Monongahela River, and to the south by railroad tracks separating the facility from Lysle Boulevard and the City's main business district.

As presented in the Groundwater Quality Assessment Summary Report (ICF Kaiser, 1993), the history of the Industrial Center of McKeesport dates to 1870, when the Flagler Company purchased the partially rebuilt works of the Fulton-Bolman Company in McKeesport. Shortly thereafter, the Flagler Company became incorporated as the National Tube Works. In 1899, thirteen major tube and pipe producers, including the National Tube Works, were consolidated and named the National Tube Company. On March 1, 1901, the National Tube Company became a subsidiary of the United States Steel Corporation (USS). Although the National Tube Works never included a coke plant, it served as the "mother plant" of the USS Eastern Steel Operations' tubular products section for the next 80 years.

Throughout the 1900s, the National Tube Works produced steel tube and pipe of varying sizes and characteristics. In 1969, the National Tube Works merged with the USS Duquesne Works located across the Monongahela River. Following this merger, many of the operations at the National Tube Works were shut down, including the closing of the open hearth, blooming mill, rolling mill, and all but one of the blast furnaces. The No. 1 Blast furnace was left in operation and used in the production of ferro-manganese steel. Figure 2-2 shows the mill operations as they appeared in the 1980s.

In 1987, the National Tube Works was shut down, and ownership was transferred to Allegheny County in 1989. In 1990, the Allegheny County Industrial Development Authority transferred ownership of the 135-acre site to the RIDC Southwestern Pennsylvania Growth Fund (Growth Fund). In an effort to revitalize the City of McKeesport, create jobs, and promote economic growth, the Growth Fund began preparing the site for redevelopment as an industrial park. This ongoing effort has included:

- The removal and off-site disposal of PCB and PCB-contaminated electrical equipment;
- Removal, decontamination, and off-site disposal of materials from tanks, vessels, equipment, and piping;
- Asbestos abatement;
- Staging, removal, transportation, and off-site disposal of approximately 2000 drums;
- Removal of eight underground storage tanks;
- Remediation of over 100 concrete pits and sumps;
- Removal, transportation, and off-site disposal of waste piles;
- Renovation of selected existing buildings and portions of buildings;
- Demolition of a number of buildings not appropriate for renovation;
- Construction of new infrastructure;



- Construction of a new building housing an industrial operation near the main entrance of the facility; and
- Refurbishment of a portion of the McKeesport Commons facility for use by Echostar.

In 1993, the property was designated as a General Industrial District by the City of McKeesport. The subdivided parcels within the Industrial Center of McKeesport are therefore permitted for uses such as manufacturing, printing and publishing, warehouse/storage, vehicle repair, and railroad or truck terminals. Other conditional uses for which the land has been approved include research and development, testing laboratories, and warehouse/storage facilities for hazardous materials.

New infrastructure has been completed at the site, including the construction of a paved roadway and curbing. A building and parking lot were constructed over the site of the former blast furnaces. This building was originally constructed for a producer of metalized paper products, and is now occupied by a distributor of automotive and pet products. In total, six existing buildings have been or will be renovated for future use. Activities at the Seamless Pipe Mill building are currently focusing on exterior renovation and roofing; however, a large portion of the building was renovated in late 1998 and is currently occupied by a tenant.



3.0 SITE CHARACTERIZATION METHODOLOGIES

A scope of work was developed to augment the information developed during several previous site characterization activities, and to evaluate the site in the context of the Pennsylvania Land Recycling Program. In March 1998, an Environmental Site Assessment Work Plan for the Act 2 program was submitted to the Pennsylvania Department of Environmental Protection (PADEP) for its review. A copy of the Work Plan is provided in Appendix A. This Work Plan was approved by PADEP by letter dated April 27, 1998 sent by Mr. Fred Baldassare, P.G. to Mr. Mark Urbassik of KU Resources, Inc. A copy of this letter is included in Appendix B. Upon this approval, the Work Plan was subsequently implemented.

The following summarizes the scope of work of the investigatory activities performed at the site pursuant to the March 1998 Work Plan.

3.1 Soil Quality Investigation

The purpose of the soil quality investigation was to characterize the site and identify immediate, direct, or imminent threats to human health and the environment. As such, the soil program focused on surface and subsurface soils in areas of potential concern based on knowledge of historical operations, and also evaluated the general site-wide surface soil quality.

Based on the available information regarding the former mill operations at the property and observations made at the property, several areas were identified that warranted additional soil quality investigation activities:

- The interior of the Seamless Pipe Mill;
- The exterior of the existing major buildings, along the "drip lines" (edge of roof) of these buildings:
- The above-ground storage tank (AST) area between the Seamless Pipe Mill and the River
- The AST area adjacent to the railroad bridge;
- The area where containerized waste materials are piled between the Seamless Pipe Mill and the River;
- The area between the Roundhouse and the River; and
- The area where the culverted Crooked Run exits the property.

In addition to these specific areas of interest, random sampling was performed to evaluate the general surface soil quality across the remainder of the property.

The following soil sampling program was implemented at the property:

Sixty soil borings were installed in the interior of the Seamless Pipe Mill (three per bay). One
composite surface soil sample and one composite subsurface soil sample were collected in each
bay (40 composite samples total). The subsurface soil sampling targeted sampling intervals that
were immediately below the level of the base of adjacent pits within the specific bays.



All composite samples were analyzed for TAL inorganics (6000/7000-series Methods). Ten of the composite samples (selected based on field observations) were analyzed for semi-volatile organics (SVOCs) (Method 8270) and PCBs (Method 8080). Ten discrete samples (selected based on field observations) were also analyzed for volatile organics (VOCs) (Method 5035/8260B).

- Ten surface soil samples were collected at the drip line around the Seamless Pipe Mill building.
 These samples were analyzed for TAL inorganics.
- One surface soil sample was collected at the drip line around each of the remaining five major buildings. These samples were analyzed for TAL inorganics.
- One soil boring was installed in each of the following locations, targeting areas of visibly stained surface soils, if present:
 - The containerized waste pile to the north of the Seamless Pipe Mill;
 - The AST area to the north of the Seamless Pipe Mill;
 - The area immediately to the north of the Roundhouse;
 - The AST area between the two bridges; and
 - The Crooked Run area near the River outfall;

These borings were advanced to the observed water table. Samples were collected from approximate depth intervals of 0-0.5 feet, 2-5 feet, and immediately above the observed saturated zone, and analyzed for TAL inorganics, VOCs, SVOCs, and PCBs.

• The entire Industrial Center property was gridded into a 100-foot by 100-foot grid, and grid nodes were assigned a reference number. Twenty grid nodes were randomly selected for surface soil sampling. At the request of PADEP, two additional sampling points were added to the east of the McKeesport-Duquesne bridge due to the absence of randomly-selected sampling points in this area (the former scrap house area). Sampling locations were field-located by measuring from available reference points. Surface soil samples were collected from each selected grid node and analyzed for TAL inorganics, SVOCs, and PCBs.

Soil sampling locations are shown on Figures 3-1 and 3-2.

Surface soil sampling was performed using a decontaminated trowel or Geoprobe direct-push hydraulic sampling unit. Subsurface soil sampling was performed using a Geoprobe unit or hollow-stem auger equipment with split-spoon sampling. Upon sample retrieval, the field geologist logged the sample, screened the sample in the field for organic constituent content using a H-Nu photoionizer, and placed the appropriate aliquots into sample jars for delivery to the laboratory. Boreholes were backfilled with bentonite upon completion of the boring.



3.2 Groundwater Quality Investigation

The purpose of the groundwater investigation was to characterize site groundwater quality. Previous groundwater sampling rounds were conducted by DLA in 1988 and ICF Kaiser in 1993. The monitoring well network used by ICF Kaiser, which included many of the wells installed and sampled by DLA, is currently in place with the exception of Well MW-15. These wells are shown on Figure 3-1. This existing monitoring well network provided sufficient coverage to complete the groundwater quality characterization of the facility.

The twelve existing monitoring wells in and immediately adjacent to the study area were re-developed using bailers or pumps. Development water was collected and ultimately placed into the city sewer system pursuant to a discharge permit. Concurrent with re-development efforts, wells were sounded and compared to their original depths to confirm their integrity and usability. Any necessary repairs to the well heads and pads were also made.

All existing wells were sampled two weeks following well re-development, on July 11 through 13, 1998. Prior to sampling, water levels were measured in order to generate water level contour maps. The wells were purged and sampled in accordance with KU Resources' standard operating procedures. Sample aliquots were filtered (for TAL metals only), placed into sample jars, placed on ice, and transported to the laboratory on the day of sampling. Purge water was collected and ultimately placed into the city sewer system pursuant to the discharge permit.

Groundwater samples were analyzed for TAL inorganics (6000/7000-series Methods), VOCs (Method 8260), SVOCs (Method 8270), and PCBs (Method 8080).

A second sampling round was completed for all wells at the site on March 17, 1999, following the same methodology described above. Ammonia analyses were not performed for this sampling round. As a result, the wells were re-sampled on April 19, 1999 and the samples were submitted for ammonia analysis only.

In addition to the groundwater sampling activities, the shoreline along the entire Industrial Center property was surveyed on foot and using a boat, to identify current and former outfall locations and determine if any visible seeps were present. No seeps causing a sheen in the Monongahela River were noted during either of these surveys. The approximate locations of these outfalls are presented on Figure 3-1.

3.3 Other Site Characterization Activities

Twenty samples were collected to characterize waste materials present in pits inside the Seamless Pipe Mill building, and in containers to the west of the Seamless Pipe Mill building. Representative samples were collected from these two areas, and were analyzed for SVOCs (Method 8270), PCBs (Method 8080), TAL inorganics (6000/7000-series Methods), and VOCs (Method 5035/8260B).

Solids samples were collected from each of the three wastewater outfall basins located along the river bank. These samples were also analyzed for SVOCs (Method 8270), PCBs (Method 8080), TAL inorganics (6000/7000-series Methods), and VOCs (Method 5035/8260B).



Paint samples were collected from ten locations inside the Seamless Pipe Mill building to determine lead content. Different colors/paint types were sampled to provide a general characterization. These samples were scraped from surfaces that were at approximate eye level.

3.4 Quality Assurance/Quality Control Sampling

Quality Assurance /Quality Control (QA/QC) sampling was performed to verify the accuracy and precision of environmental quality data collected during this assessment. QA/QC Sampling for this project consisted of collecting two duplicate waste samples, one duplicate drip line sample, two duplicate grid samples, two duplicate groundwater samples, and two field blank water samples. Due to the limited sample volume associated with the soil boring equipment used, duplicate samples could not be obtained during the soil boring program.

Duplicate drip-line and grid sample results generally correspond very well with the associated duplicate samples. The only exception is the semi-volatile results from surface soil grid sample GS-18 and its associated duplicate. The GS-18 duplicate indicated concentrations of acenaphthalene, anthracene, fluoranthene, phenanthene, and pyrene at 0.07mg/kg, 2.24 mg/kg, 24.7 mg/kg, 2.18 mg/kg, and 20.0 mg/kg respectively. The original GS-18 sample indicated that none of these constituents were present above the detection limit of 0.01 mg/kg. These concentration variances are not believed to be attributable to sampling or laboratory error, but are likely an indication of the heterogeneous nature of semi-volatile constituents within surficial soils. The absence of inorganic constituent concentration variances between the original drip-line and grid samples and the associated duplicates support this conclusion. It should be noted that these concentrations are well below both the soil-to-groundwater and direct contact MSCs.

The waste duplicate sample results, when compared to the original results, reflected a variance in iron and manganese concentrations of two to three orders of magnitude. Additionally, naphthalene and toluene were detected in sample WS-16 but were not detected in the duplicate. Variations of one to less than one order of magnitude were also noted for several other constituents. As with the dripline and grid sample duplicates described previously, these concentration variances are likely to be the result of the heterogeneous nature of the waste material.

Duplicate groundwater samples corresponded very well with the associated original groundwater samples, with no unreasonable variances present. Water field blanks indicated no detections of organic constituents, and only several detected inorganic constituents. The detected inorganic constituents are present at very low concentrations and are not believed to be indicative of sampling-or laboratory-induced contamination of the blanks.

These QA/QC results indicate that the environmental quality data collected for the environmental media during this assessment are adequately representative of site conditions. As can be expected, the results indicate that waste materials sampled are heterogeneous in nature.

3-4



4.0 SITE CHARACTERIZATION

The following sections present information describing the physical and environmental quality setting of the site. This information is compiled from data obtained during previous investigations and the investigatory work performed pursuant to the approved Work Plan.

4.1 Results of Previous Investigations

Four environmental investigations were previously performed for the subject property at the Industrial Center of McKeesport facility:

- An Environmental Assessment conducted in 1987/1988 by Duncan Lagnese, Inc. (DLA);
- A Groundwater Contamination Study conducted in 1988 by DLA;
- A Groundwater Quality Assessment conducted by ICF Kaiser Engineers in 1993; and
- A Soil Assessment Program conducted at the Power House/Boiler House portion of the Industrial Center of McKeesport property by ICF Kaiser in 1996.

The 1996 Soil Assessment Program for the Power House/Boiler House area (ICF Kaiser, 1997) was designed to evaluate this area in the context of the (then) new Pennsylvania Land Recycling Program. However, because regulatory closure of this portion of the property has not yet been finalized, the investigation results are being incorporated with the results of the current investigation, and the entire Industrial Center of McKeesport property is being consolidated under a single Notice of Intent to Remediate pursuant to the Land Recycling Program.

4.1.1 Geologic and Hydrogeologic Setting

Regional and site geology and hydrogeology were discussed by both DLA (1988, 1988a) and ICF Kaiser (1993). At the site, a surficial fill unit is present that is comprised primarily of poorly sorted slag ranging to cobble size. This unit ranges to as much as 35 feet thick. The natural soil underlying the slag fill generally consists of layers of sand and silty clay, interspersed with gravel. This unit is present to depths of up to 80 feet. The upper bedrock, encountered at a depth of 80 feet in Well MW-11, was reported to be a red-gray clay shale.

Based on water levels in the monitoring wells installed by DLA and ICF Kaiser, ICF Kaiser (1993) determined that the aquifer present in the unconsolidated materials (slag fill and natural soils) at the site is continuous to the bedrock surface, and that groundwater flow is north, to the Monongahela River. Water levels were generally found between depths of 25 to 30 feet below grade. Groundwater flow velocities were estimated to be between one and ten feet per year.

4.1.2 Environmental Quality

4.1.2.1 DLA Groundwater Study

The 1988 groundwater study performed by DLA concluded that a very localized zone of elevated ammonia concentrations existed in the area downgradient of the Seamless Pipe Mill. In addition, based on the results of groundwater sampling, petroleum hydrocarbon contamination had not occurred in either the area surrounding the Oil House or the area surrounding the Power House and



nearby underground storage tank. The results of this investigation are compiled with other data and discussed in further detail in Section 4.2.3.

4.1.2.2 ICF Kaiser Groundwater Quality Assessment

The stated objective of the ICF Kaiser Groundwater Quality Assessment (1993) was to further characterize the quality of the groundwater at the site and the potential impact it may have on human health. Based on the information collected by DLA and sampling results from existing and newly-installed monitoring wells, ICF Kaiser concluded the following:

- The site has historically been used, and will be used in the future, for industrial purposes.
- The use of site groundwater as a drinking water supply is not likely to occur due to requirements
 of the City of McKeesport.
- Tetrachloroethene (PCE) was detected in MW-19, an upgradient monitoring well, in excess of the federal Maximum Contaminant Level (MCL).
- Chloroform was detected at a level slightly above the detection limit in MW-14. This
 concentration was well below the MCL.
- Trichloroethene (TCE) was detected at a level slightly above the detection limit and MCL in MW-6, but the result was invalidated due to a missed holding time. Results from a resampling of the well were below the detection limit.
- Maximum concentrations of iron, manganese, chloride, and sulfate detected at the site exceeded secondary MCLs for drinking water.
- Total (unfiltered) lead concentrations exceeded the federal action level of 0.015 mg/L in five site wells. Dissolved (filtered) lead concentrations exceeded the action level in one well (MW-6 at 0.047 mg/L).
- Two base/neutral compounds (acenaphthene and fluorene) were detected in MW-1, at or slightly above the detection limit. These results were substantially below the calculated Drinking Water Equivalent Level for these compounds. No other base/neutral compounds were detected at the site.
- No PCBs were detected in site samples.
- Cyanide was detected in three monitoring wells, at concentrations that were less than ten percent of the MCL.
- Ammonia was detected in each of the monitoring wells sampled. Only the ammonia concentration in MW-1 (89.8 mg/L) exceeded the U.S. EPA Health Advisory Level of 34.0 mg/L. Results from the adjacent deep well MW-11 and from other shallow wells in this general area indicate that the presence of elevated ammonia concentrations is limited to the upper portion of the aquifer in the immediate vicinity of MW-1.

The results of this investigation are compiled with other data and discussed in further detail in Section 4.2.3.



4.1.2.3 ICF Kaiser Soil Assessment Program – Power House/Boiler House Area Three identified areas of interest were evaluated during this program: the Electric Repair Shop/Power House; the Pipe Storage Building; and the Walker Thickener Area. Additional random sampling was also performed across the study area outside of these areas of interest. All soil samples were collected at a depth of 6 inches below ground surface, because reviews of the area by DLA and ICF Kaiser identified only potential sources of constituents to surface soils.

A full copy of the ICF Kaiser report is included as Appendix C. It should be noted that the conclusions made by ICF Kaiser in this report were based on draft Pennsylvania Act 2 regulations and standards that have since been finalized, with some changes. As a result, the ICF Kaiser conclusions have been updated below.

Analytical results for this investigation are summarized in Tables 4-1(a) through 4-1(d). These Tables also list the Pennsylvania non-residential direct contact and non-residential used aquifer soil-to-groundwater Act 2 standards (Medium Specific Concentrations, or MSCs) for each constituent. Five inorganic constituents (cadmium, iron, lead, mercury, and vanadium) were detected at concentrations exceeding their respective Pennsylvania Act 2 Statewide Health standards in at least one soil sample. These exceedances are also indicated on Tables 4-1(a) through 4-1(d).

No organic constituents were detected at concentrations that exceeded their respective MSCs.

A review of the investigation methodology and results indicates that the ICF Kaiser investigation adequately characterized soil quality in this portion of the Industrial Center of McKeesport for Act 2 purposes. The nature of the potential source areas would lead to soil quality impacts in surface soils, which were sampled extensively in each of the specific areas of interest, as well as through a random sample collection process. None of the findings are suggestive of soil quality impacts at depth.

4.2 Results of Current Site Characterization Activities

4.2.1 Geology and Hydrogeology

The stratigraphic information collected during the deep soil boring program was consistent with earlier site geologic interpretations. Appendix D includes drilling logs from the newly installed borings, as well as available drilling logs from the previously installed soil borings and monitoring wells. Fill was found to be predominantly slag or a slag soil blend, with minor occurrences of other fill material, such as brick. One notable exception was the occurrence of a hard blue sand material observed throughout the 0-11 foot interval in boring locations B-2 and B-3. The only natural soil encountered in situ was orange brown silt in Boring B-5 at a depth of 18 feet. Saturated materials were encountered at depths ranging from 17 to 27 feet below grade in the soil boring program.

Beneath the Seamless Pipe Mill building, the shallow soil borings encountered primarily slag and sand fill materials. The encountered materials were observed to be very heterogeneous in nature. Numerous initial attempts at soil boring locations encountered refusal, resulting in one or more adjustments to the boring location to allow sampling at the appropriate depth intervals.



Water level contour maps were developed for both of the groundwater sampling rounds, and are presented on Figures 4-1 and 4-2. These figures indicate that groundwater flow is to the adjacent Monongahela River, and that flow patterns are similar to those developed during the previous investigations.

4.2.2 Soil Quality

4.2.2.1 Seamless Pipe Mill

Soil quality results for the subsurface of the former Seamless Pipe Mill building are summarized in Table 4-2(a) (inorganic constituents), Table 4-2(b) (semi-volatile constituents), and Table 4-2(c) (volatile organic constituents). Samples where constituents exceeded Pennsylvania Act 2 MSCs for either the soil-to-groundwater pathway or for the direct exposure pathway are highlighted in these Tables. Laboratory analytical data reports are included in Appendix E. The results are summarized as follows:

- Lead exceeded Act 2 direct contact MSC for surface soils in one location (Bay 6, surface soil).
- Lead exceeded Act 2 soil-to-groundwater MSC for "used" aquifers in four locations (Bays 5 and 6, surface soil and Bays 11 and 20, subsurface soil), but did not exceed the Act 2 MSC for "nonused" aquifers.
- Benzo(b,k)fluoranthene exceeded the soil-to-groundwater MSC for benzo(b)fluoranthene (which
 are more stringent than criteria for benzo(k)fluoranthene) for "used" and "non-used" aquifers at
 one location (Bay 20, subsurface soil).
- Methylene chloride exceeded the soil-to-groundwater MSC for "used" aquifers in one sample (Bay 17 at a depth of 3.5 to 5 feet). This is a common laboratory-related contaminant, and may not be associated with site conditions.

4.2.2.2 Building Drip Lines

Soil quality results for the surface soil sampling at the building drip lines are summarized in Table 4-3. Samples where constituents exceeded Pennsylvania Act 2 MSCs for either the soil-to-groundwater pathway or for the direct exposure pathway are highlighted in these Tables. Laboratory analytical data reports are included in Appendix F. The results are summarized as follows:

- Lead exceeded the direct contact MSC in drip line samples DL-1, DL-2, DL-4, DL-14, DL-17, and DL-21.
- Lead exceeded the soil-to-groundwater MSC for "used" aquifers in drip line samples DL-1, DL-2,
 DL-4, DL-6, DL-11, DL-13, DL-14, DL-17, DL-20, and DL-21.

4.2.2.3 Site Surface Soils

Soil quality results for the random surface soil sampling across the site are summarized in Table 4-4. Samples where constituents exceeded Pennsylvania Act 2 MSCs for either the soil-to-groundwater pathway or for the direct exposure pathway are highlighted in these Tables. Laboratory analytical data reports are included in Appendix G. The results are summarized as follows:



- Lead and vanadium exceeded the direct contact MSC at sampling point GS-17.
- Lead exceeded the soil-to-groundwater MSC for "used" aquifers at sampling points GS-17 and GS-18/GS-18 duplicate.

4.2.2.4 Potential Discrete Source Areas

Soil quality results for the deep soil borings completed in potential source areas are summarized in Table 4-5(a) (inorganic constituents) and Table 4-5(b) (organic constituents). Samples where constituents exceeded MSCs for either the soil-to-groundwater pathway or for the direct exposure pathway are highlighted in these Tables. Laboratory analytical data reports are included in Appendix H. The results are summarized as follows:

- Vanadium exceeded the direct contact MSC at Boring B-1 (surface soil sample).
- Methylene chloride exceeded the soil-to-groundwater MSC for "used" aquifers in Boring B-5 (surface soil sample).

4.2.3 Groundwater Quality

Groundwater quality data collected during all of the site investigative activities (from 1987 to present) are summarized, by well, in Table 4-6. Laboratory analytical data reports are included in Appendix I. During the first sampling event for well MW-1, performed by DLA in December 1987, naphthalene was detected at a concentration of 0.900 mg/L. This value exceeds the nonresidential MSC for used aquifers, but does not exceed the MSCs for non-use aquifers. Naphthalene was non-detect in this well in four of the five subsequent sampling rounds (a concentration of 0.0194 mg/L was detected in the July 1998 sample), suggesting that the December 1987 value is in error. Tetrachloroethene (PCE) was detected in MW-19 (an upgradient well) at concentrations exceeding the MSCs for both used and non-use aquifers in both ICF Kaiser sampling rounds, and at a concentration exceeding the MSC for used aquifers in the first Remedial Investigation sampling round. Lead exceeded the MSC for used aquifers in monitoring wells MW-1, MW-3, MW-4, MW-5, MW-9, MW-10, and MW-11 in various sampling events. The detection limit for lead in the first Remedial Investigation sampling round exceeded the MSC, preventing a detailed comparison of these values with the MSC. The detection limit for vanadium exceeded the MSC for used aquifers in both Remedial Investigation sampling rounds.

Analytical data from the Remedial Investigation were also compared with the historical data acquired by DLA and ICF Kaiser (as summarized in Section 4.1.2, above). No PAHs were detected in MW-1 in either Remedial Investigation sampling round. The concentrations of tetrachloroethene (PCE) in upgradient well MW-19 decreased to a level slightly above the detection limit in the first Remedial Investigation sampling round, and to below the detection limit in the second sampling round. Ammonia concentrations at MW-1 have remained fairly consistent over the course of the various investigations, with a maximum of 125 mg/L being detected in the first Remedial Investigation sampling round. The notably elevated ammonia concentrations in two other wells (MW-7 and MW-9) have also remained fairly constant with time.



4.2.4 Waste and Other Materials

4.2.4.1 Containerized Waste Materials

Analytical results for the representative waste samples collected from the area to the west of the Seamless Pipe Mill building are summarized in Table 4-7(a) (inorganic constituents) and Table 4-7(b) (volatile and semi-volatile organic constituents). Laboratory analytical data reports are included in Appendix J. Pennsylvania Act 2 does not identify standards that are applicable to these materials. A review of the data indicates that calcium and iron are the predominant inorganic constituents detected in the containerized waste materials. Volatile organic constituents were detected in samples WS-1, WS-3, WS-4, and WS-6, while semi-volatile constituents were primarily non-detect.

4.2.4.2 Seamless Pipe Mill Pits

Analytical results for the representative waste samples collected from the pits in the Seamless Pipe Mill building are summarized in Table 4-8(a) (inorganic constituents) and Table 4-8(b) (volatile and semi-volatile organic constituents). Laboratory analytical data reports are also included in Appendix J. Pennsylvania Act 2 does not identify standards that are applicable to these materials. A review of the data indicates that calcium and iron are the predominant inorganic constituents detected in the pits, while the lead concentration was notably elevated in sample WS-20. Organic constituents were primarily non-detect, with the exception of samples WS-14 (volatiles and acenaphthene detected), WS-17 (polynuclear aromatic hydrocarbons), WS-19 (volatile organics), and WS-20 (volatile organics and polynuclear aromatic hydrocarbons).

4.2.4.3 Outfall Basins

Environmental quality results for the solids samples collected from the three wastewater outfall basins are summarized in Table 4-9(a) (inorganic constituents) and Table 4-9(b) (organic constituents). Laboratory analytical data reports are included in Appendix K. Pennsylvania Act 2 does not identify standards that are applicable to these materials. A review of the data indicates that aluminum, calcium, and iron are the predominant inorganic constituents detected in the three basins. The cobalt concentration in sample SB-1 (the eastern outfall basin) is notably elevated above the cobalt concentration in the other basins, and the magnesium and lead concentrations in Sample SB-3 (the western basin) are notably elevated above the concentrations in the other basins. No volatile or semi-volatile organic constituents were detected in any of the three outfall basin samples.

4.2.4.4 Lead Paint Survey

Lead paint analyses are summarized in Table 4-10. Laboratory analytical data reports are included in Appendix L. Lead was present in all of the paint samples collected.



5.0 SOURCE AND IDENTIFICATION OF CONSTITUENTS OF CONCERN

5.1 Conceptual Site Model

Information regarding site hydrogeology indicates that there is a relatively thick unsaturated zone present across the site, with groundwater levels occurring at depths of 25 to 30 feet. The upper unit is predominantly composed of slag fill, with minor occurrences of other fill materials such as brick, sand, and soil.

There is no evidence suggesting the disposal of chemical waste materials during the placement of this fill unit. Any constituents present in soils at the facility would therefore be expected to have originated from facility operations, and entered site soils at or near the ground surface. For these constituents to enter groundwater, they would have to migrate through the remaining thickness of unsaturated fill via a leaching mechanism to a depth of 25 to 30 feet below grade. Any subsequent constituent migration in the groundwater would be to the north, with ultimate discharge to the Monongahela River.

In a typical setting, multiple migration pathways exist that create the potential for contact between chemical constituents and receptors. These pathways include direct contact through ingestion or dermal contact with soil. In addition, constituents may migrate from soil-to-groundwater and be ingested through that pathway. Finally, groundwater may migrate to surface water, and present an exposure potential for ecological or human receptors.

5.2 Constituents of Concern in Soil

Only a few exceedances of Act 2 soil quality standards have been noted at the site, and the majority of these exceedances are for direct contact criteria. The constituents that have been detected above the direct contact MSCs are:

- Iron
- Lead
- Vanadium

The constituents that have been detected above the soil-to-groundwater MSCs are:

- Lead
- Cadmium
- Mercury
- Benzo(b,k)fluoranthene
- Methylene Chloride

5.3 Constituents of Concern in Groundwater

Groundwater samples collected at the site in the various sampling events performed between 1987 and the present time have exceeded the non-residential MSCs for used aquifers for the following constituents:



- Naphthalene
- Tetrachloroethene (PCE)
- Lead
- Vanadium

Only tetrachloroethene (PCE) exceeded the non-residential MSC for non-use aquifers. It should be noted that the only PCE detections at the site were in Well MW-19, which is an upgradient well. It should also be noted that the only detection of naphthalene of significance was at MW-1 in the December 1987 sampling round. Naphthalene concentrations for all subsequent sampling rounds have been either non-detect or near non-detect, suggesting that the initial result may be in error.

Based on the results of the current and previous investigations, the effects of past facility operations on groundwater quality appear to be limited. No notable discrete sources of organic or inorganic constituents have been identified in the investigations completed at the site over the past ten years. Given the amount of time since the mill was put into operation, and the amount of time since the mill was finally closed, it is highly unlikely that any sources that would adversely affect groundwater quality remain unidentified at the site. As a result, static groundwater quality conditions have been attained, and constituent reduction mechanisms (such as dilution, dispersion, attenuation, and degradation) are the primary factors controlling groundwater quality at the site.

5.4 Pathways of Interest

The following pathways of interest have been identified at the Industrial Center of McKeesport site:

- Direct contact with waste materials:
- Direct contact with soil;
- Soil-to-groundwater;
- Direct contact/ingestion of groundwater; and
- Groundwater to surface water.

5.5 Pathway Elimination

Four of the above five identified pathways can be eliminated in the following manner:

- Direct contact with waste materials: Wastes will be removed and disposed in a permitted off-site location;
- Direct contact with soil: The soil will be covered with pavement or vegetated soil, or a combination of both;
- Soil-to-groundwater: The use of groundwater will be prevented through institutional controls in the form of a deed restriction; and
- *Direct contact/ingestion of groundwater:* The use of groundwater will be prevented through institutional controls in the form of a deed restriction.



Only the groundwater to surface water pathway at this site cannot be addressed by pathway elimination. The risk posed by this pathway has been evaluated in accordance with the Technical Guidance Manual (PADEP, 1997) in the form of a Baseline Risk Assessment presented in the following Section.



6.0 BASELINE RISK ASSESSMENT

The groundwater-to-surface water pathway is the only site pathway that is not addressed via the pathway elimination processes described in Section 5.0. The implementing regulations for Act 2 provide for determining compliance with surface water quality standards from a diffuse groundwater discharge. Section 250.309 (c) states:

"For purposes of determining compliance with surface water quality standards from a diffuse surface or groundwater discharge, the person shall determine the expected instream regulated substance concentrations, that are attributable to releases at the site, using mass balance techniques for groundwater/surface water mixing at design flow conditions."

Section 250.309 (c)(1) goes on to state that:

"If the results indicate that surface water quality standards are being achieved, no action is required."

This evaluation approach is described in further detail at Section IV.A.3 of the Technical Guidance Memorandum (Fate and Transport Analysis – Impacts to Surface Water from Diffuse Flow of Contaminated Groundwater). In this guidance, a formula for evaluating such impacts is provided, along with the types of instream flow data that must be used for the evaluation.

As described in the conceptual site model (Section 5.1), the ultimate discharge point for groundwater containing source-related constituents of interest is the Monongahela River. Sufficient site information is available to support the Pennsylvania Act 2 methodology for determining the potential for effects on surface water quality in the Monongahela River from a diffuse discharge of groundwater. A conservative determination (i.e. overestimation of the potential for effects on surface water quality) can be developed by using conservative input parameters to this methodology. A determination that concentrations of constituents are and will be below applicable State water quality standards using highly conservative assumptions provides a clear indication that site conditions are not creating and will not create unacceptable concentrations of constituents in the receiving surface water.

The potential concentrations of constituents from groundwater that might enter surface water from diffuse groundwater inflow to the river in the absence of the groundwater recovery system can be estimated in a highly conservative manner by the following approach:

- Determine the representative concentration of each constituent of interest in groundwater;
- Determine the constituent flux in groundwater moving from the site into the river;
- Determine the flow rate (volume per unit time) of the river;
- Determine the representative concentration of each constituent of interest in the river following groundwater inflow; and
- Compare the representative concentrations in the river with Pennsylvania water quality standards.



This step-wise approach is described in detail below.

Representative Concentrations in Groundwater: Representative concentrations in groundwater recovery system can be conservatively estimated by using maximum constituent concentrations detected in the history of groundwater monitoring activities at the site. The use of these maximum concentrations is conservative because: 1) this approach assumes that groundwater concentrations are constant (at the maximum detections) across the site; and 2) this approach does not take into account constituent mass removal that occurs through natural processes (such as dilution, dispersion, attenuation, and degradation).

Constituent Flux in Groundwater: The constituent flux in groundwater moving from the source area into the river can be conservatively estimated using the representative concentration of each constituent (above), and the groundwater flow rate (in volume per unit time) from the site area to the river. The groundwater flow rate can be conservatively estimated using aquifer characteristics and water level information.

The lateral width of the site is approximately 6,400 feet, and the maximum saturated thickness of the fill unit was determined to be approximately 55 feet. The maximum hydraulic gradient across the site (determined from Figure 4-1) is 0.038 ft/ft. Hydraulic conductivity for the saturated interval was estimated as the maximum of the slug test results reported by DLA (1988) of 4.34×10^{-4} feet per minute or 0.625 feet per day. Groundwater flow in the saturated fill interval can be estimated by using Darcy's law:

Q = KiA

where:

Q is the flow rate in volume per unit time; K is the hydraulic conductivity (1.94 x 10^{-1} ft/day); i is the maximum hydraulic gradient (0.012 ft/ft); and A is the saturated cross-sectional area (6,400 ft by 55 ft, or 352,000 ft²).

This equation yields a flow (Q) in the fill unit of approximately 819 ft³ per day (6,132 gallons per day).

A conservative estimate of the constituent flux into the river can be determined using the representative concentrations and the above flow rate. It is important to note that this estimated constituent flux is conservatively high, in that it: 1) uses maximum detected groundwater concentrations; 2) assumes that these maximum concentrations are constant over the cross-sectional flow area; 3) assumes that the maximum concentrations will remain constant along the flow path to the river, and are not reduced by dilution, dispersion, or attenuation mechanisms; and 4) uses the maximum hydraulic gradient expected.

Monongahela River Flow Rate: The representative flow rate in the Monongahela River was determined using historical flow records maintained by the U.S. Geological Survey. The most recent 10 years of available flow records (1988 to 1998) from the Braddock gauging station (available on-line from U.S.G.S.) were used to calculate the 7 day/10 year low flow (Q_{7-10}) and the Harmonic Mean Flow



for the Monongahela River. These results are 1,037,857,683 gallons per day and 3,781,761,142 gallons per day, respectively. Calculations are presented in Appendix M.

Predicted River Concentrations and Comparison with Water Quality Standards: The resultant concentrations of constituents of interest in the Monongahela River have been conservatively estimated using the estimate of constituent flux from groundwater to the river and the flow rate in the river. The resultant concentrations in the river following groundwater inflow were determined using the following equation (PADEP, 1997):

$$C_{sw} = C_{gw} \times Q_{gw} / Q_{sw}$$

where Q_{sw} is the harmonic mean flow for potentially carcinogenic constituents (as identified by PA. Code Title 25, Chapter 16) and the Q_{7-10} for non-carcinogenic constituents.

Table 6-1 presents the resultant concentrations predicted in the Monongahela River. Table 6-1 also presents the applicable surface water quality standards for the constituents of interest. The calculation and supporting information are more fully detailed in Appendix M. As shown in Table 6-1, all of the estimated in-stream concentrations are well below the surface water quality criteria for both aquatic life and for human health. In light of the conservative assumptions used to determine constituent flux to the river, the actual concentrations of site-related constituents entering the river as a result of diffuse groundwater flow are expected to be much lower. Given this outcome, Section 250.309(c)(1) of the Pennsylvania Code states that no action is required to address the groundwater to surface water pathway at the site.



7.0 ECOLOGICAL RECEPTORS

The purpose of the ecological receptor evaluation is to determine if species or habitats of concern exist on the site. An evaluation has been performed to identify the presence of any species or habitats of concern. An evaluation has also been performed to identify any endangered or threatened species located within 2,500 feet of the property boundary. An evaluation for the presence of wetlands at the property was also conducted.

7.1 Methods

The evaluation was conducted by visually surveying the property for the presence of species or habitats of concern or any threatened or endangered species. The area surrounding the property was evaluated for the presence of threatened or endangered species by evaluating the property through aerial photographs and USGS topographic maps in addition to visually observing the river bank and other accessible areas.

7.2 Property Description

As described in Section 2.0, the Industrial Center of McKeesport and surrounding areas to the east and west (along the Monongahela River) are currently, or have been historically used by steel manufacturing facilities. Railroad tracks exist immediately to the south of the site, with the Monongahela River on the northern boundary and a densely populated commercial and residential area on the far side of the southern tracks. Over the course of years, the property and surrounding areas have been developed through the construction of buildings, paving of roadways and parking lots, the placement of massive amounts of fill (mostly slag), and the complete management of surface water flow through a storm sewer system. This type of development severely hinders the formation of natural habitats and thereby eliminates the potential for occurrence of most animal and plant species.

The ground surface at the Industrial Center of McKeesport property is generally covered with buildings, pavement, or fill (mostly slag or railroad ballast). The areas covered with buildings and pavement are generally devoid of plant and animal life with exception of the weeds and scrub trees rooted in cracks and other areas in which sufficient soil has accumulated to allow plant growth. The areas covered with fill vary from no vegetation to sparse vegetation, depending on the type of fill and the volume of traffic in the area. However, the vegetation present in the fill areas is limited to weeds and scrub trees. No significant indications of wildlife were observed on the property.

Future plans for the property include landscaping non-paved areas. Landscaping will consist of planting grass, trees, and shrubs over a large portion of the site. These actions will dramatically increase the biodiversity of the property and will be a drastic improvement over current conditions.

7.3 Ecological Receptors

No ecological receptors exist at the Industrial Center of McKeesport property. Most of the property is devoid of life, and the remaining areas of the property are sparsely covered with weeds and scrub trees, and the surrounding areas are highly developed. As a result, the only potentially viable habitat for ecological receptors is in the Monongahela River. However, as discussed in Section 6.0, a fate and transport model has been developed to assess potential impacts to the chemical quality of the



river. The results of the fate and transport model indicate that the diffuse flow of groundwater from the property into the Monongahela River is not adversely impacting the water quality in the river, and is therefore not posing an unacceptable risk to human health or the environment.

To verify the non-presence of endangered or threatened species at the property, KU Resources contacted Mr. Andrew Shiels, a group leader with the Non-Game and Endangered Species Section of the Pennsylvania Fish and Boat Commission. Mr. Shiels indicated that he had no knowledge of any threatened or endangered species at the site location. This information is documented in the letter presented in Appendix N.

As a result of the above, there are no potential hazards to ecological receptors on the property or in the river that are posed by environmental conditions at the Industrial Center of McKeesport property. In accordance with the Technical Guidance Manual (PADEP, 1997), no further ecological screening is required.



8.0 CLEANUP PLAN

The compilation of previous and current site physical and environmental quality information for the Industrial Center of McKeesport presented in this report demonstrates that a full site characterization has been completed, and that this information is sufficient to evaluate the property pursuant to the Pennsylvania Land Recycling Program. The report identifies five potentially complete exposure pathways at the site:

- Direct contact with waste materials:
- Direct contact with soil;
- Soil-to-groundwater;
- Direct contact/ingestion of groundwater; and
- Groundwater to surface water.

RIDC does not intend to eliminate all contamination on the property because the constituents at the site do not prevent occupation of the site based on the intended future uses. Pathways of exposure for future users of the site to remaining site constituents will be eliminated through the implementation of engineering and institutional controls. The site will be reused for office space, laboratory, warehousing and distribution, manufacturing, assembling, testing, servicing, repairing, and research and development purposes. This reuse excludes developing the site or any portion for recreational areas, schools, nursing homes and other residential-style facilities, unless a residential Statewide Health Standard would first be attained at the site.

RIDC is demonstrating attainment of the Site-Specific Standard, using, to a major extent, pathway elimination. The first four of the identified pathways are being, or will be eliminated through the use of waste removal activities, pavement and vegetated soil covers, and formal groundwater use restrictions. The report demonstrates through the use of a highly conservative evaluation that the fifth, the groundwater-to-surface water pathway, meets Pennsylvania water quality criteria and poses no unacceptable risk to human health and the environment.

The pathway elimination processes currently underway or planned for the Industrial Center of McKeesport are described in more detail below.

Waste Removal

Waste materials present in pits, sumps, tanks, and containers will be removed from the Industrial Center of McKeesport for off-site disposal at an approved facility. The specifications and statements of work contained in the bid package dated May 16, 2000 related to materials removal at the ICM are included as Appendix O. These bid specifications and statements of work require:

- Preparation of a health and safety plan for the waste removal activities;
- Additional characterization of these materials as needed for disposal purposes;
- Removal of the materials in the pits;
- Removal of the materials in the tanks and demolition/scrapping of the tanks;



- Removal of the containerized materials, and disposal/scrapping of the containers;
- Disposal of wastes and resultant debris not qualifying as scrap in a permitted facility; and
- Preparation of a report documenting the project activities and appropriate disposal of materials.

Soil Cover

Part of the interior of the Seamless Pipe Mill building has been paved during redevelopment activities, and the remainder of the building is planned to be paved as redevelopment continues. Outdoor areas will be covered during site redevelopment activities. Cover types include asphalt or concrete paving (for parking areas and roadways) and soil (for landscaped and grass areas). If soil is used as a cover material, it will consist of 0.5 feet of clean fill, capable of sustaining vegetation. These actions have or will eliminate the direct contact pathway, in accordance with the Act 2 requirements.

The soil cover pathway elimination process will be maintained into the future through the use of a site-wide Operations and Maintenance (O&M) Plan. A copy of the O&M Plan for the Industrial Center of McKeesport is included as Appendix P.

In the event of a sale of property where a cover is used for pathway elimination purposes, the deed transferring this property will define the implementation and maintenance pursuant to the O&M Plan as a responsibility of the purchaser.

Soil Management

Soils encountered during site development must be managed to limit potential impacts to human health and the environment. The soils will be managed by detailing the excavation, stockpiling, backfilling, revegetation, and environmental control procedures to be implemented when intrusive work such as trenching, excavating test pits, drilling, etc. is to be performed at the site. A Soil Management Plan has been prepared to provide a standard approach to be used by the property owner, tenants, and subcontractors that is consistent with a risk reduction strategy pursuant to Pennsylvania's Act 2. Potential exposures to soils at the Industrial Center of McKeesport site are or will be addressed by pathway elimination through the use of soil covers. The protocols detailed in the Soil Management Plan are to be followed in the event that the soil cover (expected to consist of either asphalt/concrete pavement or soil) is disturbed during future redevelopment or site maintenance activities. The Soil Management Plan is presented in Appendix Q.

Groundwater Use Restrictions

The identified exceedances of soil-to-groundwater MSCs and groundwater MSCs at the site will be addressed through a pathway elimination process. There is currently no use of groundwater at the site, and a public water supply services the site and the surrounding area. Existing monitoring wells and any subsequently identified former water supply wells on the property will be properly abandoned and future groundwater use at the site will be prohibited through the use of a deed restriction. Language in the deed restriction will be as follows:



"Groundwater beneath the property will not be used for any purpose without first obtaining approval from the Pennsylvania Department of Environmental Protection, and providing adequate treatment in consideration of the intended groundwater use."

The existing and planned pathway elimination processes described above prevent direct contact or ingestion of the constituents of interest, thereby preventing a dose to a potential receptor. As a result, there is no unacceptable risk to human health under current site conditions. The anticipated future use of the site and the planned deed notices/restrictions will maintain these pathway elimination processes.

Well Abandonment

In order to facilitate unhindered site development and to eliminate direct pathways to groundwater, groundwater monitoring wells at the site will be abandoned. The wells will be abandoned in accordance with Chapter 7 of the PADEP Groundwater Monitoring Guidance Manual dated February, 1996. A description of the proposed well abandonment procedure is presented below.

An assessment will initially be performed to verify the integrity of the annular well seal. The well abandonment will then proceed through one of two methods depending on the initial assessment.

If the annular well seal is found to be intact, the well will be abandoned in place by filling the screened interval with bentonite pellets or chips. The remaining interval of well casing will then be sealed with neat cement grout emplaced with a tremie pipe. Once the neat cement grout has cured, the well casing will be removed to a minimum depth of three feet below ground surface.

If the annular well seal is found not to be intact, the well will be abandoned by over-drilling the boring to a depth three feet greater than the total depth of the well. Drilling will be performed with either air rotary or auger methods with a minimum boring diameter equal to the original boring diameter. The void will then be sealed with either a bentonite-cement grout or a bentonite grout emplaced with a tremie pipe.



9.0 PROJECT DOCUMENTATION

9.1 Introduction

Act 2 sets forth specific public notice, public participation, and reporting requirements for facilities undergoing evaluation or remediation. Under the Site-Specific Standard, the activities include submittal of a Notice of Intent to Remediate (NIR) the site to the PADEP, notifying the local municipality of the contents of the NIR and supplying a copy of the NIR to the local municipality, and publishing a summary of the NIR in a newspaper of general circulation in the area. Upon submittal of any report under the Site-Specific Standard, a notice must also be sent to the local municipality and a summary of the findings and recommendations of the report must be published in a newspaper of general circulation in the area. During the 30-day period following the newspaper publication, the local municipality may request to be involved in the remediation or reuse plans for the facility, or request that a Public Involvement Program Plan be developed.

Project reporting provisions pertaining to signatures of individuals or companies participating in the remediation activities who are seeking a release of liability and a list of contacts involved with the project are also required under the provisions of the Technical Guidance Manual.

9.2 Notice of Intent to Remediate

The NIR for the Industrial Center of McKeesport site was submitted to the PADEP by transmittal letter dated April 5, 2000. Appendix R is a copy of the transmittal letter and NIR, and a copy of the return receipt documenting acceptance of the submittal by the PADEP on April 7, 2000.

On April 7, 2000, a summary of the NIR was published in the McKeesport Daily News, which is a newspaper of general circulation in the Monongahela Valley. Appendix S is a copy of the notice published and a copy of the notarized proof of publication for the notice. Also included in Appendix S are the notices of the submittal of this report.

The City of McKeesport was notified via letter dated April 5, 2000 of the submittal of the NIR, publication of the legal notice in the newspaper, and its opportunity to become involved with the remediation and reuse plans or to request a Public Involvement Program Plan. Appendix T is a copy of the letter submitted along with a copy of the return receipt documenting receipt of the letter. Also included in Appendix T are the notices to the City of the submittal of this report.

9.3 Public Comments and Participation

No comments have been received from the public in response to the publication of the summary of the NIR in the McKeesport Daily News. The City of McKeesport has not requested to become involved with the remediation or reuse plans for the facility and has not requested that a Public Involvement Program Plan be developed.

Additional activities related to public participation consisted of notifying the City of McKeesport of submittal of this report and publishing a summary of the findings and recommendations of the report in the McKeesport Daily News. Any comments received in response to these activities will also be included in the Final Report, along with the responses thereto.



9.4 Project Participants

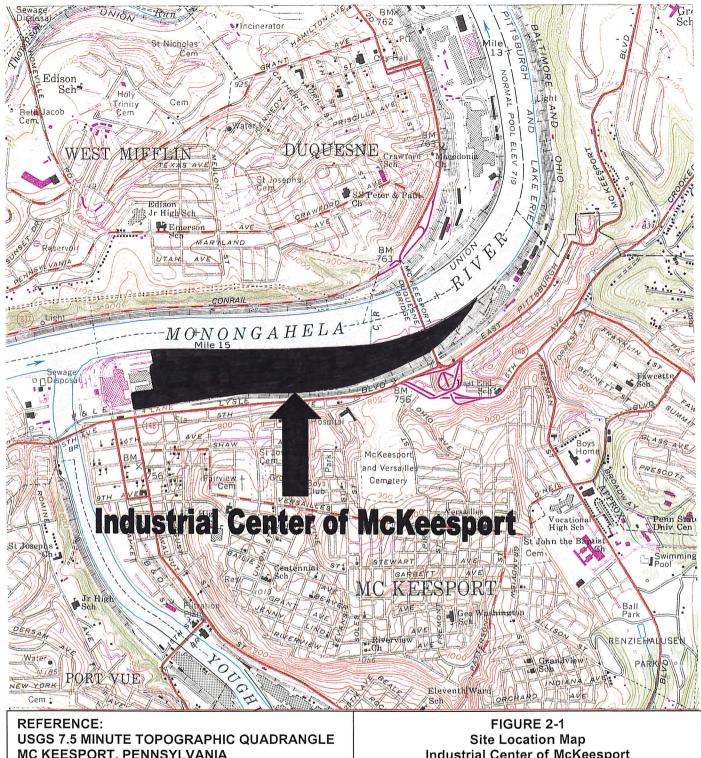
The RIDC has participated in the development of the Remedial Investigation, Risk Assessment, and Cleanup Plan reports for the facility. Appendix U presents the signatures of an authorized representative from RIDC. A list of project contacts is provided in Appendix V.

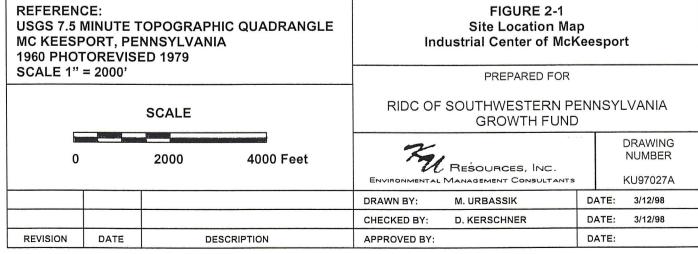


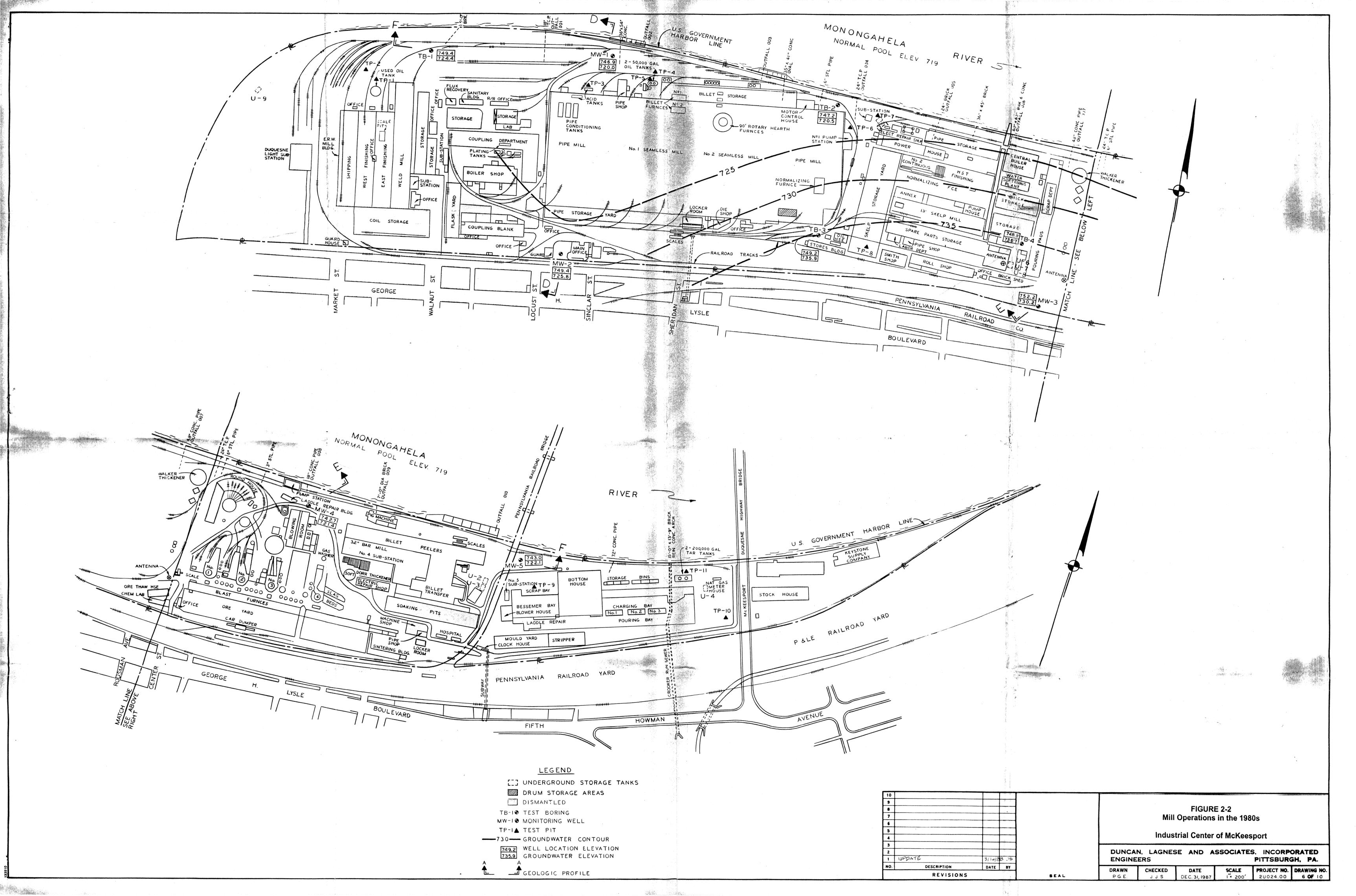
LIST OF REFERENCES

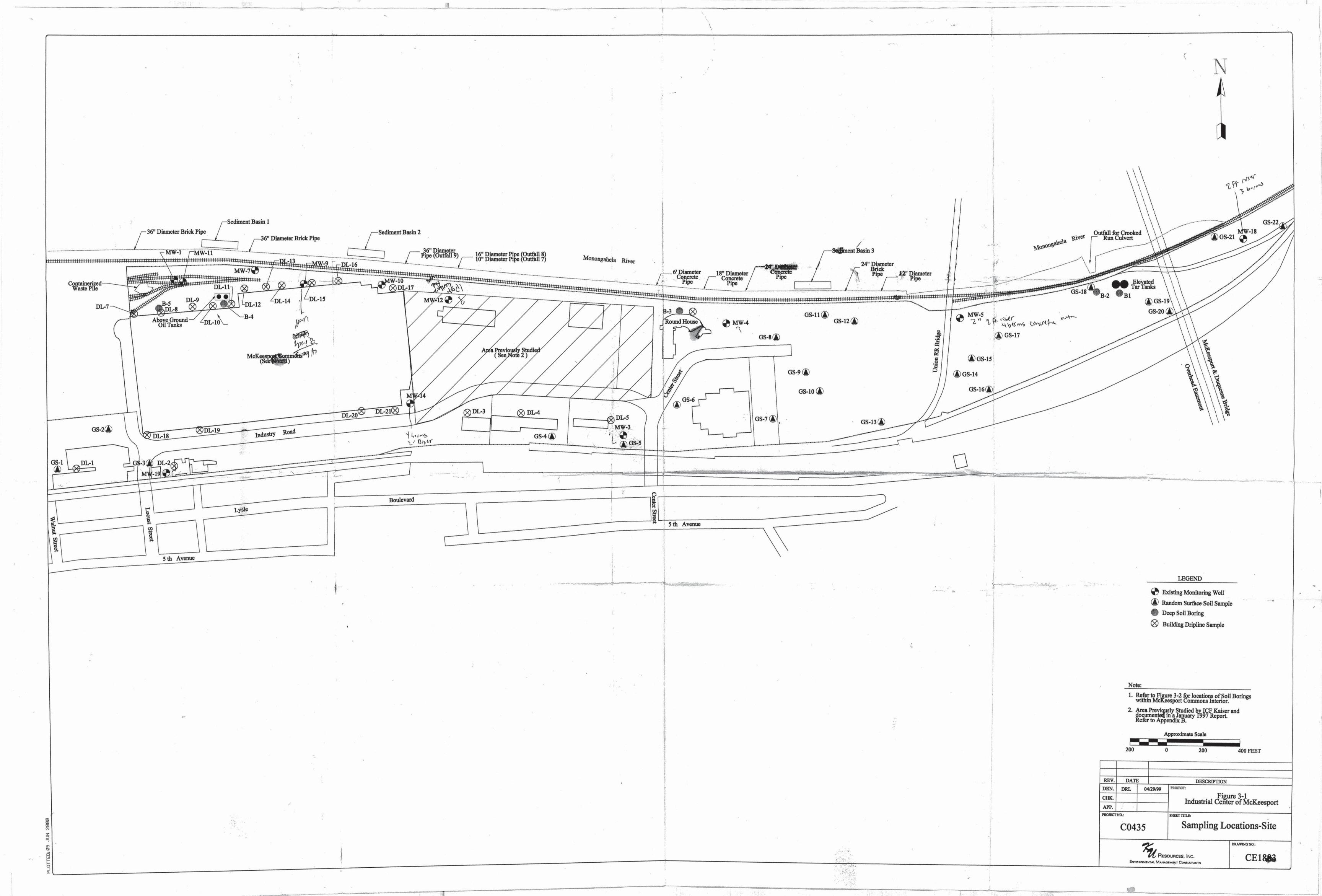
- Duncan, Lagnese and Associates, Inc., October 1988, Groundwater Contamination Study, Final Report, USX Duquesne Plant, USX National Plant
- Duncan, Lagnese and Associates, Inc., May 1988, Final Report, Environmental Assessment of the USX Corporation National and Duquesne Plants
- ICF Kaiser, January 1997, Soil Assessment Program Summary Report, Industrial Center of McKeesport, McKeesport, PA
- ICF Kaiser Engineers, Inc., August 1993, Groundwater Quality Assessment Summary Report, Industrial Center of McKeesport, McKeesport, PA
- Pennsylvania Department of Environmental Protection, December 1997, Final Draft, Pennsylvania's Land Recycling Program, Technical Guidance Manual



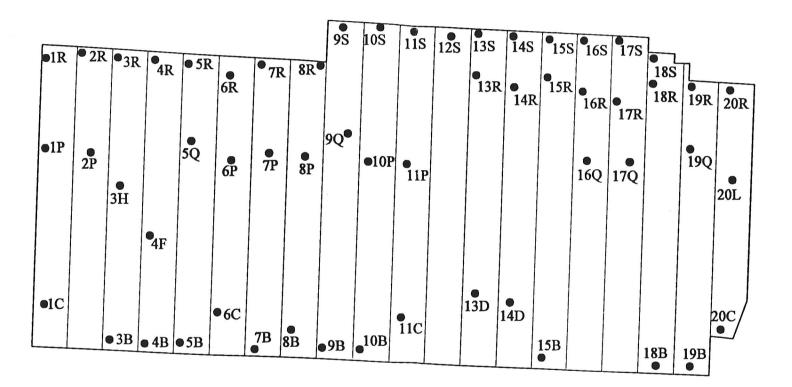












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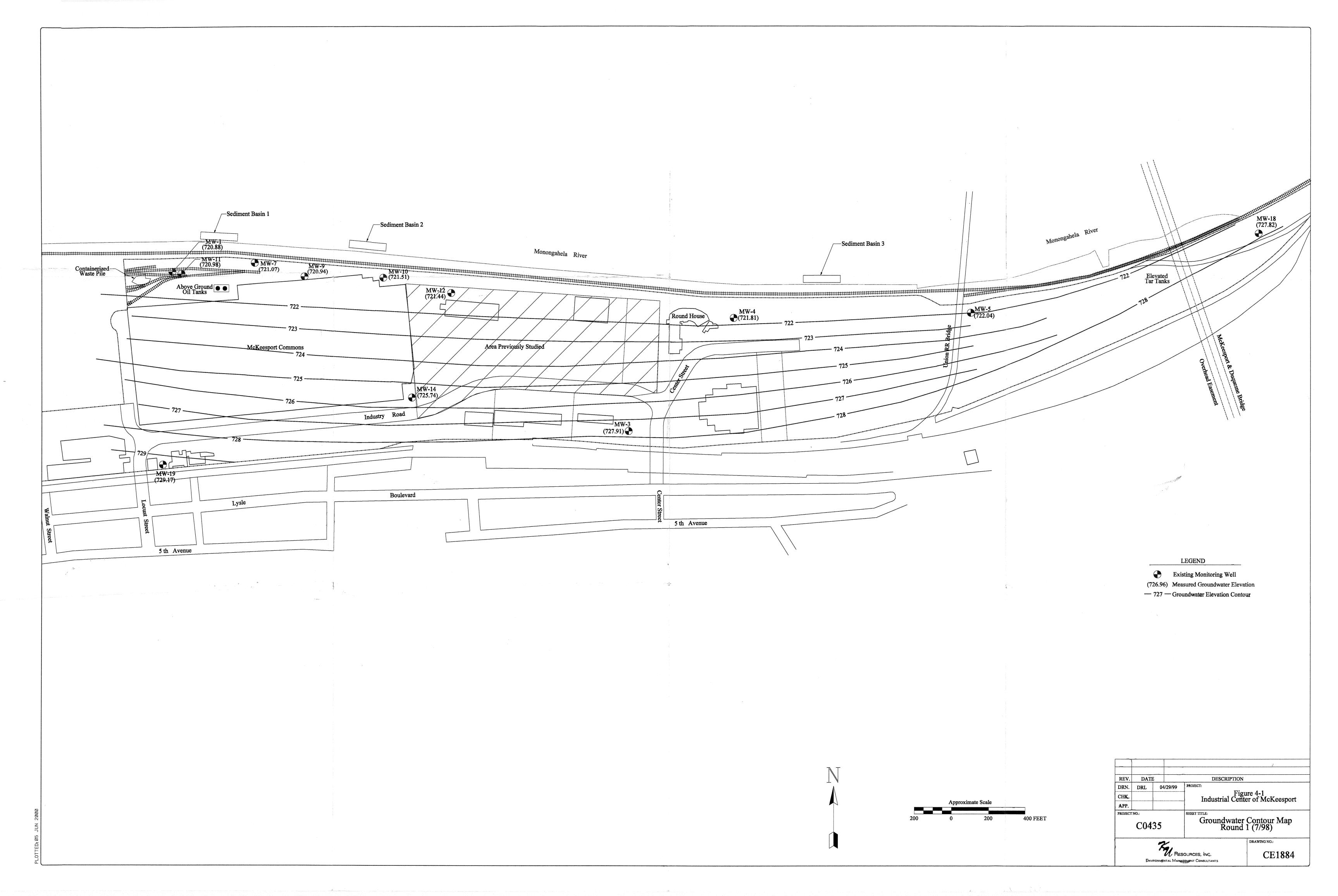
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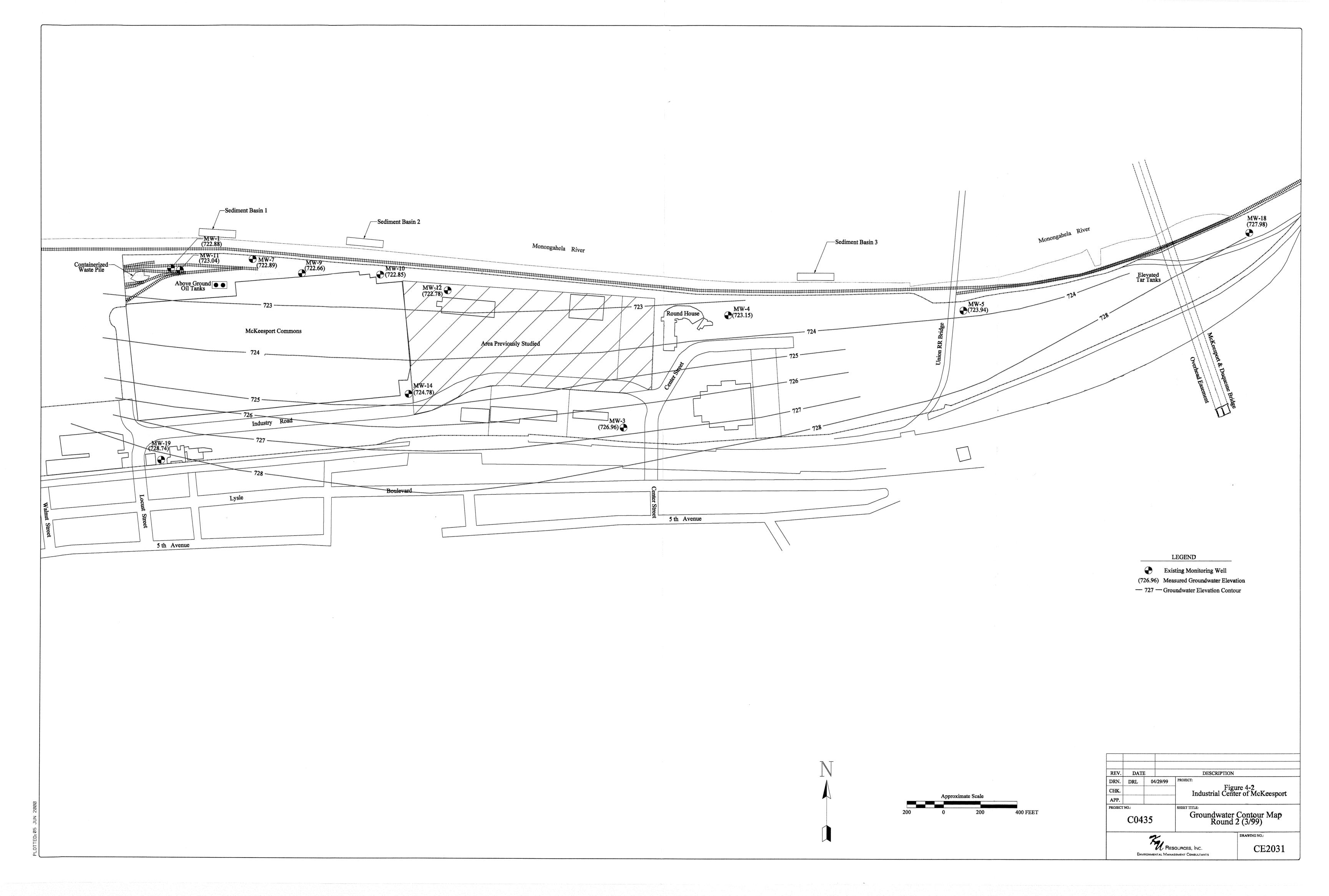
Interior Soil Boring Location

Approximate Scale					
200	0	200	400 FEET		

REV.	DATI	2	DESCRIPTION		
DRN.	DRL	04/27/99	Figure 3-2		
CHK.			Industrial Center of McKeesport		
APP.			industrial cent	or or mercespers	
РВОЛЕСТ NO.: C0435			Soil Samplin Seamless M	Soil Sampling Locations Seamless Mill Building	
FU. RESO			COURCES, INC	CE1878	

017ED:12 JUL 1999







KU Resources, Inc.

Environmental Management Consultants

Project:

RIDC - McKeesport

McKeesport Commons

Driller:

Method:

Geologist: Von E. Fisher

Direct Push

Geo-Environmental Drilling, Inc.

Boring:

B-1 1 of 2

Sheet: Date:

05/20/98

Location: Refer to Figure 3-1

			<u></u>	т	
Depth (ft)	Lithology	Lithologic Description	Comments	PID	Well Construction
_ _ 0					
-		FILL: sand, slag, cinders, etc.	boring backfilled with bentonite	< 1 ppm	ı
-					
				< 1	
<u> </u>				ppm	
		SAND Medium Overned Well to		< 1 ppm	
<u> </u>		SAND: Medium Grained, Well to PoorlySorted, Llight Brown			
	77777	FILL: Sand, Slag, Etc.			
_		TIEE. Gaint, Glag, Etc.		<1 ppm	
- - 15					
				< 1 ppm	
_					



KU Resources, Inc.

Environmental Management Consultants

Project: RIDC - McKeesport

McKeesport Commons

Geologist: Von E. Fisher

Driller: Method: Geo-Environmental Drilling, Inc.

Direct Push

Boring: B-1

Sheet:

2 of 2

Date: 05/20/98

Refer to Figure 3-1 Location:

00 Depth (ff)	Lithology	Lithologic Description	Comments	PID	Well Construction
-		FILL: Sand, Slag, Etc.		3.5 ppm	
		BOTTOM OF BORING	groundwater @ 22-feet Bottom of boring @ 24-feet		
- 25		-			
-					
- 30 -				e de la constantina del constantina de la constantina de la constantina de la constantina de la constantina de la constantina de la constantina de la constantina del constantina de la constantina de la constantina de la constantina de la constantina de la constantina de la constantina de la constantina de la constantina de la constantina de la constantina de la constantina de la constant	
l l					
_ 35					
40					



Environmental Management Consultants

Project: RIDC - M

RIDC - McKeesport

McKeesport Commons

Geologist: Von E. Fisher
Driller: Geo-Environm

Geo-Environmental/Terra Testing

Method: Direct Push/Hollow Stem Auger

Boring: B Sheet: 1

B-2 1 of 1

Date:

05/20/98

Depth (ft)	Lithology	Lithologic Description	Comments	PID	Well Construction
_ _ 0		FILL: slag, cinders, etc.		<1	
			boring backfilled with bentonite	ppm	
		FILL: Blue Sand, Very hard		< 1	
- 5			Wet from 5 to 6-feet	ppm	
-				< 1	
- 10		FILL: Blue Sand and Slag, Very Hard		ppm	
				< 1	
				ppm	
— 15 -			saturated at 15 feet		
	XXXXX	BOTTOM OF BORING			



Environmental Management Consultants

Project: I

Driller:

RIDC - McKeesport

McKeesport Commons

Geologist: Von E. Fisher

Geo-Environmental/Terra Testing

Method: Direct Push/Hollow Stem Auger

Boring: |

Date:

B-3 1 of 2

Sheet:

05/20/98

Location: Ref

Depth (ft)	Lithology	Lithologic Description	Comments	PID	Well Construction
_ _ 0		FILL: Slag and Cinders		< 1	
			boring backfilled with bentonite	ppm	
		SAND: Blue Sand and Slag		<1	
<u> </u>				ppm	
				< 1	
- 10				ppm	
				< 1	
				ppm	
— 15 –					
				< 1 ppm	



Environmental Management Consultants

Project: RIDC - McKeesport

McKeesport Commons

Geologist: Von E. Fisher

Driller: Geo-Environmental/Terra Testing

Method: Direct Push/Hollow Stem Auger

Boring: B-3

Sheet: 2 of 2

Date: 05/20/98



Environmental Management Consultants

Project: R

Driller:

Method:

RIDC - McKeesport

McKeesport Commons

Geologist: Von E. Fisher

Geo-Environmental Drilling, Inc.

Direct Push

Boring:

B-4 1 of 2

Sheet: Date:

05/20/98

Depth (ft)	Lithology	Lithologic Description	Comments	PID	Well Construction
- O		FILL: sand, slag, cinders, etc.	boring backfilled with bentonite	1 ppm	
_ 5				3 ppm	
				2 ppm	
-				8 ppm	
— 15 - -		SILT: Clayey, Orange Brown to Olive Gray		2 ppm	
- 20					



Environmental Management Consultants

Project: RIDC - McKeesport

McKeesport Commons

Geologist: Von E. Fisher

Method:

Driller:

Geo-Environmental Drilling, Inc.

Direct Push

Boring: B-4 Sheet:

2 of 2

Date:

05/20/98

S Depth (ft)	Lithology	Lithologic Description	Comments	PID	Well Construction
- - - - 25		FILL: Slag, Silt Etc.		2 ppm	
		BOTTOM OF BORING	groundwater @ 27-feet Bottom of boring @ 28-feet		
— 30 _ _					
- 3 5					
_ 40					



Environmental Management Consultants

Project: RIDC

RIDC - McKeesport

McKeesport Commons

Geologist: Von E. Fisher

Driller:

Geo-Environmental Drilling, Inc.

Method: Direct Push

Boring: I

B-5 1 of 1

05/20/98

Date: Location:

Sheet:

Depth (ft)	Lithology	Lithologic Description	Comments	PID	Well Construction
- O		FILL: sand, slag, cinders, etc.	boring backfilled with bentonite	1 ppm	
				2 ppm	
5 				2 ppm	
				1.5 ppm	
— 10 –					
_				1 ppm	
15 - -			groundwater @ 17-feet	2 ppm	
- - 20		SILT: Clayey, Orange Brown to Olive Gray	Bottom of boring @ 20-feet		



Environmental Management Consultants

Project:

RIDC - McKeesport

McKeesport Commons

Geologist: Von E. Fisher

Method:

Driller:

Geo-Environmental Drilling, Inc.

Direct Push

Boring:

01 C

1 of 1

Sheet: Date:

05/14/98

Refer to Figure 3-2 Location:

Depth (ft)	Lithology	Lithologic Description	Comments	PID	Well Construction
- o					
		FILL: coarse white sand and slag	boring backfilled with bentonite	11 ppm	
	-Z-Z-Z-	SILTY CLAY: orange brown, moist			
_ 5	-Z-Z-Z- -Z-Z-Z- -Z-Z-Z-			11 ppm	
	-Z-Z-Z- -Z-Z-Z- -Z-Z-Z-				
	-Z-Z-Z- -Z-Z-Z- -Z-Z-Z-			13 ppm	
- 10 -	-7-7-7-	SAND AND SILT: layered, orange brown and gray, moist to wet			
-		Bottom of Boring at	refusal @ 12-feet		
 15	-	,			
_					
20					



Project:

RIDC - McKeesport

McKeesport Commons

01 P

Boring: Sheet:

1 of 1

Method:

Geologist: Von E. Fisher

Direct Push

Date:

05/14/98

Environmental Management Consultants

Driller: Geo-Environmental Drilling, Inc.

Location:

Depth (ft)	Lithology	Lithologic Description	Comments	PID	Well Construction
- 0					
		FILL: slag and bricks	boring backfilled with bentonite	7 ppm	
	-Z-Z-Z- -Z-Z-Z- -Z-Z-Z-	SILTY CLAY: medium red/brown, moist			
_	-7-7-7- -7-7-7- -7-7-7-			9 ppm	
5		FILL: slag			
	-Z-Z-Z- -Z-Z-Z-	SILTY CLAY: medium red/brown, moist with some sand lenses			
	-7-7-7- -7-7-7-			7 ppm	
10	-Z-Z-Z- -Z-Z-Z- -Z-Z-Z-				
	-7 <u>-</u> 7 <u>-</u> 7 <u>-</u> 7 -7 <u>-</u> 7 <u>-</u> 7-				
		Bottom of Boring at	refusal @ 12-feet		
15					



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Geologist: Von E. Fisher

Driller: Method: Geo-Environmental Drilling, Inc.

Direct Push

Boring:

01 R

1 of 1

Sheet: Date:

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Depth (ft)	Lithology	Lithologic Description	Comments	PID	Well Construction
- - 0		fill: slag, weathered brick, sand and gravel	boring backfilled with bentonite	3 ppm	
5				4 ppm	
- - - 10		Bottom of Boring at	refusal @ 10-feet	3.5 ppm	
- - - 15					



Project:

Driller:

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Boring:

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Location:

Refer to Figure 3-2

Environmental Management Consultants Method: **Direct Push**

Depth (ft)	Lithology	Lithologic Description	Comments	PID	Well Construction
- O		FILL: coarse white sand with some discoloration and a slight organic odor	boring backfilled with bentonite	5 ppm	
- 5			VOC Sample collected at 4-feet	5 ppm	
- 10				6 ppm	
- 15		Bottom of Boring at	refusal @ 12-feet		
- 20					



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Driller:

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Depth (ft)	Lithology	Lithologic Description	Comments	PID	Well Construction
— O		FILL: sand and slag, red brown to gray	boring backfilled with bentonite	4 ppm	
- 5				2.5 ppm	
- 10		Bottom of Boring at	refusal @ 11-feet	1.5 ppm	
- - 15					
20					



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Driller:

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Depth (ft)	Lithology	Lithologic Description	Comments	PID	Well Construction
O		FILL: clay, soft, with some layers of slag	boring backfilled with bentonite	7 ppm	
5				7 ppm	
	-Z-ZZZZZZZZZZZZ	SILTY CLAY: orange brown and light gray, moist		9 ppm	
_ 10	-Z-Z-Z- -Z-Z-Z- -Z-Z-Z- -Z-Z-Z-	Bottom of Boring at: Refusal @ 12 feet	refusal @ 12-feet		
15 _					
- 20					



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Date:

Location:

05/14/98 Refer to Figure 3-2

Method: **Direct Push**

Depth (ft)	Lithology	Lithologic Description	Comments	PID	Well Construction
- o		FILL: clay, soft, with some layers of slag	boring backfilled with bentonite	7 ppm	
_ 5				7 ppm	
- 10	-Z-Z- -Z-Z-Z- -Z-Z-Z- -Z-Z-Z-	SILTY CLAY: orange brown and light gray, moist		9 ppm	
	-Z-Z-Z- -Z-Z-Z- -Z-Z-Z-	Bottom of Boring at: Refusal @ 12 feet	refusal @ 12-feet		
— 15 —					
20					



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Depth (ft)	Lithology	Lithologic Description	Comments	PID	Well Construction
- o		fill: slag, sand, etc. some silty soil	boring backfilled with bentonite	2 ppm	
- 5	-Z-Z-Z- -Z-Z-Z- -Z-Z-Z- -Z-Z-Z-	silty clay: orange brown with some gray, moist		2 ppm	
_ 10	-Z-Z-Z- -Z-Z-Z- -Z-Z-Z- -Z-Z-Z- -Z-Z-Z- -Z-Z-Z-			1 ppm	
		sandy silt: light gray and orange brown	slight petroleum odor from 11 to 12-feet VOC sample collect at 11.5-feet	5 ppm	
- 15 - -		Bottom of Boring at	refusal @ 15-feet		
20					



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Sheet:

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Location:

Boring:

Depth (ft)	Lithology	Lithologic Description	Comments	PID	Well Construction
- O 		FILL: coarse white sand, weathered brick, and slag, slightly moist	boring backfilled with bentonite	7 ppm	
- 5 -			·	7 ppm	
10 		Bottom of Boring at	refusal @ 12-feet	5 ppm	
- 15					



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Driller:

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Date: 05/15/98

Depth (ft)	Lithology	Lithologic Description	Comments	PID	Well Construction
<u> </u>		fill: black slag, moist to wet	boring backfilled with bentonite	4 ppm	
-				3 ppm	
- 5 -		silt: olive brown, some brick frags (fill), moist sandy silt: orange brown, moist to very moist			
- - 10		·		3 ppm	
		Bottom of Boring at	refusal @ 12-feet		
_ — 15					
20					



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Geologist: Von E. Fisher

Driller:

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Depth (ft)	Lithology	Lithologic Description	Comments	PID	Well Construction
- 0		fill: slag, sand, etc.	boring backfilled with bentonite	5 ppm	
- - - 5		•	0.5-foot layer of black slag with organic odor @ 3-feet	2 ppm	
- - - 10		silt: clayey, orange brown and gray		1 ppm	
_ 15 		Bottom of Boring at	refusal @ 12-feet		
- 20					



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Refer to Figure 3-2

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Method: Direct Push

			_	y	
Depth (ft)	Lithology	Lithologic Description	Comments	PID	Well Construction
- O		FILL: coarse white sand and slag, moist	boring backfilled with bentonite	3 ppm	
- - 5 -			,	3 ppm	
- - 10		Bottom of Boring at	refusal @ 11-feet	2 ppm	
15					



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Boring:

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05 B

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Refer to Figure 3-2

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Method: **Direct Push**

Depth (ft)	Lithology	Lithologic Description	Comments	PID	Well Construction
- 0		FILL: layers of slag/bricks, silty clay orange brown gray, moist to wet	boring backfilled with bentonite	< 1 ppm	
- 5				<1 ppm	
		SILT: clay/sand, orange brown and gray, moist		< 1 ppm	
- 10 -			some wet slag and silt layers		
- - - 15		Bottom of Boring	refusal @ 12-feet		



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Refer to Figure 3-2

€ Depth (Lithology Lithologic Description Comments PID Well Construction 0 FILL: slag, sand, etc. < 1 ppm boring backfilled with bentonite < 1 ppm - 5 < 1 ppm SILT: sandy, moist, orange brown - 10 Bottom of Boring refusal @ 12-feet - 15



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Depth (ft)	Lithology	Lithologic Description	Comments	PID	Well Construction
- 0		FILL: white sand and slag		< 1 ppm	
~		Ell L red/brown silt with come class	boring backfilled with bentonite		
_ 5		FILL: red/brown silt with some slag (weathered brick)		<1 ppm	
_ 10				< 1 ppm	
~		FILL: slag		< 1 ppm	
- - 15		Bottom of Boring	refusal @ 14-feet		
_ 20				L	



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Sheet:

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Location:

Date:

Depth (ft)	Lithology	Lithologic Description	Comments	PID	Well Construction
- 0		FILL: white sand and slag	boring backfilled with bentonite	< 1 ppm	
- - 5		Bottom of Boring	refusal @ 3.5-feet blue gray staining from 2 to 3-feet		
-					
_ 10					
- 15		-			



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Sheet: Date:

Location:

05/16/98 Refer to Figure 3-2

€ Depth (Lithology Lithologic Description PID Comments Well Construction 0 FILL: white sand and slag < 1 ppm boring backfilled with bentonite < 1 ppm 5 < 1 ppm 10 **Bottom of Boring** stopped @12-feet - 15



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Depth (ft)	Lithology	Lithologic Description	Comments	PID	Well Construction
- 0 -		FILL: black slag/ash, dry	boring backfilled with bentonite	< 1 ppm	
- 5		Bottom of Boring	refusal @ 6-feet	< 1 ppm	
10					
_ _ _ _ 15					
- 15					
- 20					



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Driller: Gee

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Depth (ft)	Lithology	Lithologic Description	Comments	PID	Well Construction
- O -		FILL: sand and slag, orange brown	boring backfilled with bentonite	< 1 ppm	
_ 5		FILL: silty sand, black, strong organic odor, wet		< 1 ppm	
- 10		SILT: clayey with sand lenses, orange brown and gray, moist		< 1 ppm	
		Bottom of Boring	stopped @ 12-feet		
— 15 -					
20					



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Location:

Depth (ft)	Lithology	Lithologic Description	Comments	PID	Well Construction
- - -		FILL: iron oxide rich slag, sand, clay	boring backfilled with bentonite	< 1 ppm	
- - 5		FILL: river sand, slag, brick		<1 ppm	
_ 10				<1 ppm	
-		Bottom of Boring	stopped @ 12-feet		
- 15 -					



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Boring:

Refer to Figure 3-2 Location:

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Depth (ft)	Lithology	Lithologic Description	Comments	PID	Well Construction
- 0		FILL: sand, slag	boring backfilled with bentonite	< 1 ppm	
5				< 1 ppm	
		SILT: clayey, moist orange brown and gray, sandy			
- 10				< 1 ppm	
				< 1 ppm	
15 		Bottom of Boring	stopped @ 16-feet		
-					



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Depth (ft)	Lithology	Lithologic Description	Comments	PID	Well Construction
- - 0		FILL: slag, sand, cinders, moist	boring backfilled with bentonite	< 1 ppm	
5				< 1 ppm	
- - - 10		SILT: clayey gray	-	<1 ppm	
-		Bottom of Boring	stopped @ 12-feet		
— 15 -					



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Location:

Depth (ft)	Lithology	Lithologic Description	Comments	PID	Well Construction
- - 0		FILL: sand, slag, rock fragments	boring backfilled with bentonite	<1 ppm	
- - - 5				< 1 ppm	
- 10		CLAY: silty orange brown, moist		< 1 ppm	
		Bottom of Boring	stopped @ 12-feet		
— 15 -					
20					



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Depth (ft)	Lithology	Lithologic Description	Comments	PID	Well Construction
- O		FILL: slag, white sand, etc., moist	boring backfilled with bentonite	< 1 ppm	
5				<1 ppm	
_ 10		FILL: silty clay, red, wet, some slag		< 1 ppm	
		Bottom of Boring	stopped @ 12-feet		
- 15					



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Location:

Date:

	1		_	γ	
Depth (ft)	Lithology	Lithologic Description	Comments	PID	Well Construction
- 0	[\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\	FILL: white sand, slag, cinders, etc.		< 1	
-		The state of the s	boring backfilled with bentonite	ppm	
-					
_					
-					
- 5				< 1 ppm	
				< 1 ppm	
— 10					
-		SILT: sandy/clayey, orange brown, moist			
-	* ***** * ***** * *	Bottom of Boring	stopped @ 12-feet		
		bottom or boning	12.000		
— 15					
_					
_					
_					
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Refer to Figure 3-2 Location:

Depth (ft)	Lithology	Lithologic Description	Comments	PID	Well Construction
_			·		
- 0		FILL: sand, slag, etc.	boring backfilled with bentonite	< 1 ppm	
- 5				< 1 ppm	
- - - 10				< 1 ppm	
- - - -		SILT: clayey, orange brown, moist Bottom of Boring	stopped @ 16-feet	< 1 ppm	
20					



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Location:

Depth (ft)	Lithology	Lithologic Description	Comments	PID	Well Construction
_ _ 0		FILL: slag, sand, cinders, etc.		< 1 ppm	
			boring backfilled with bentonite		
— 5 _				< 1 ppm	
_ _ _ 10				<1 ppm	
-		Bottom of Boring	stopped @ 12-feet		
- 15					
- 20	L				



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	<u> </u>	<u> </u>	1	Т	
Depth (ft)	Lithology	Lithologic Description	Comments	PID	Well Construction
- O		FILL: slag, sand, etc.	boring backfilled with bentonite	< 1 ppm	
- 5				< 1 ppm	
_ _ 10		SILT: sandy/clayey orange brown		< 1 ppm	
-		Bottom of Boring	stopped @ 12-feet		
15 					
- 20					



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Location: Refer to Figure 3-2

 \oplus Depth (Lithology Lithologic Description Comments PID Well Construction 0 FILL: slag, sand, etc. < 1 ppm boring backfilled with bentonite refusal@ 3.5-feet **Bottom of Boring** - 5 - 10 - 15 - 20



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Location:

Denth (#)	(ii) indoor	Lithology	Lithologic Description	Comments	PID	Well Construction
- 0) [~~~~~				
			FILL: slag, fire brick, etc.	boring backfilled with bentonite	< 1 ppm	
- 5					< 1 ppm	
			Bottom of Boring	refusal@ 6-feet		
_						
- 10	0					
15	5					
-						
L 20)					



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Location: Refer to Figure 3-2

Depth (ft)	Lithology	Lithologic Description	Comments	PID	Well Construction
_					
- 0 -		FILL: sand, slag, brick, etc.	boring backfilled with bentonite	< 1 ppm	
- 5				<1 ppm	
- 10				< 1 ppm	
		SILT: clayey, gray green	slight to moderate odor from 11 to 16-feet VOC sample collected from 13.5-feet	< 1 ppm	
- 15 - -		Bottom of Boring	stopped @ 16-feet		



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Boring:

Location: Refer to Figure 3-2

Depth (ft)	Lithology	Lithologic Description	Comments	PID	Well Construction
- o		FILL: concrete, sand, slag, etc.	boring backfilled with bentonite	< 1 ppm	
_ 5 _		Bottom of Boring	refusal @ 5-feet	<1 ppm	
- 10					
— 15 —					
20					



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Date: Location:

Depth (ft)	Lithology	Lithologic Description	Comments	PID	Well Construction
- - 0		FILL: slag, sand, etc.	boring backfilled with bentonite	< 1 ppm	
5				< 1 ppm	
- 10		Bottom of Boring	refusal @ 10-feet	< 1 ppm	
- 15 - -					
20					



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Boring:

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Method: **Direct Push**

Depth (ft)	Lithology	Lithologic Description	Comments	PID	Well Construction
- o		FILL: slag, cinders and sand	boring backfilled with bentonite	< 1 ppm	
— 5 –				< 1 ppm	
- 10		Bottom of Boring	refusal @ 10-feet	<1 ppm	
_ _ _ _ 15					
_ 20					



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Location: Refer to Figure 3-2

Depth (ft)	Lithology	Lithologic Description	Comments	PID	Well Construction
- - 0		FILL: sand, clay, etc.	boring backfilled with bentonite	< 1 ppm	
- - 5				< 1. ppm	•
_ 10		1	water @ 9-feet	< 1 ppm	
-		Bottom of Boring	refusal @ 10-feet		
-					
- 15 -					
<u>-</u>					



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Refer to Figure 3-2 Location:

Depth (ft)	Lithology	Lithologic Description	Comments	PID	Well Construction
- O		FILL: sand, clay, etc.	boring backfilled with bentonite	< 1 ppm	
- - -				< 1 ppm	
- - - 10		Pottom of Posing	water @ 9-feet refusal @ 10-feet	< 1 ppm	
_		Bottom of Boring	Telusar (g) 10-leet		
- 15					



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Location: Refer to Figure 3-2

Depth (ft)	Lithology	Lithologic Description	Comments	PID	Well Construction
- - 0 -		FILL: sand, slag, etc.	boring backfilled with bentonite	< 1 ppm	
_ 5				< 1 ppm	
- 10				< 1 ppm	
		Bottom of Boring	stopped @ 12-feet		
— 15 _					



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Location:

Depth (ft)	Lithology	Lithologic Description	Comments	PID	Well Construction
_ o		FILL: slag, sand, etc.	boring backfilled with bentonite	< 1 ppm	
_ 5				< 1 ppm	
		SILT: clayey, orange brown, moist		< 1 ppm	
<u> </u>		Bottom of Boring	stopped @ 12-feet		
- 15 -					



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Refer to Figure 3-2 Location:

Depth (ft)	Lithology	Lithologic Description	Comments	PID	Well Construction
ă			Commente	'	Wen Construction
- 0		FILL: slag, sand, etc., dry, weathered concrete		< 1	
-		weatnered concrete	boring backfilled with bentonite	ppm	
5				< 1 ppm	
			-		
				<1 ppm	`
<u> </u>		Bottom of Boring	refusal @ 10-feet		
-					
— 15 -					
-				The control of the co	



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1 of 1 05/18/98

Date: Location:

Depth (ft)	Lithology	Lithologic Description	Comments	PID	Well Construction
- O		FILL: slag, sand, etc., dry	boring backfilled with bentonite	< 1 ppm	
5 		Bottom of Boring	refusal @ 7-feet	< 1 ppm	
- 10		Doctorii di Boring			•
— 15 –					



Environmental Management Consultants

Project: RIDC

RIDC - McKeesport

McKeesport Commons Geologist: Von E. Fisher

Driller:

Geo-Environmental Drilling, Inc.

Method: Direct Push

Boring: 1

15 B 1 of 1

Sheet: Date:

05/19/98

Location:

Depth (ft)	Lithology	Lithologic Description	Comments	PID	Well Construction
0 		FILL: slag, etc.	boring backfilled with bentonite	< 1 ppm	
- - 5			;	< 1 ppm	
- - - 10		SILT: sandy clayey, orange brown, moist			
_ 15		Bottom of Boring	stopped @ 12-feet		



Environmental Management Consultants

Project: RIDC - McKeesport

McKeesport Commons

Geologist: Von E. Fisher

Driller:

Geo-Environmental Drilling, Inc.

Method:

Direct Push

Boring:

15 R 1 of 1

Sheet: Date:

05/18/98

Location: Refer to Figure 3-2

Depth (ft)	Lithology	Lithologic Description	Comments	PID	Well Construction
- - -		FILL: sand, slag, etc.	boring backfilled with bentonite	10 ppm	
_ 5		FILL: black from 3-16'	poor recovery, strong organic odor and sheen from 3 to 16-feet	10 ррт	
— 10			VOC sample collected from 10-feet	10 ppm	
_ _ _ 15				10 ppm	
- 20		Bottom of Boring	stopped @ 16-feet		



Environmental Management Consultants

Project:

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McKeesport Commons

Method:

Geologist: Von E. Fisher

Driller:

Geo-Environmental Drilling, Inc.

Direct Push

Boring:

15 S 1 of 1

Sheet: Date:

05/18/98

Location:

Depth (ft)	Lithology	Lithologic Description	Comments	PID	Well Construction
- 0 -		FILL: slag, sand, etc.	boring backfilled with bentonite	< 1 ppm	
_ _ _ 5				< 1 ppm	
_ _ _ 10		Bottom of Boring	refusal @ 9.5-feet	<1 ppm	
- 15 -					
20					



Environmental Management Consultants

Project: RIDC - N

RIDC - McKeesport McKeesport Commons

Geologist: Von E. Fisher

Driller:

Geo-Environmental Drilling, Inc.

Method: Direct Push

Boring:

16 R 1 of 1

Sheet: Date:

05/19/98

Location:

Depth (ft)	Lithology	Lithologic Description	Comments	PID	Well Construction
- - 0 -		VOID: boring advanced through vertical pipe in	boring backfilled with bentonite		
5		FILL: sand, slag		< 1 ppm	
-				< 1 ppm	
- - 10				< 1 ppm	
- 15				< 1 ppm	
_		Bottom of Boring	refusal @ 18-feet		



Environmental Management Consultants

Project:

RIDC - McKeesport

McKeesport Commons

Geologist: Von E. Fisher

Driller: Method: Geo-Environmental Drilling, Inc.

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16 S

1 of 1

Sheet: Date:

05/19/98

Location: Refer to Figure 3-2

Depth (ft)	Lithology	Lithologic Description	Comments	PID	Well Construction
- o -		FILL: sand, slag, bricks, etc.	boring backfilled with bentonite	< 1 ppm	
- 5				< 1 ppm	
- - - 10				< 1 ppm	^
		Bottom of Boring	stopped @ 12-feet		
— 15 —					
20					



Environmental Management Consultants

Project: RIDC - McKeesport

McKeesport Commons

Geologist: Von E. Fisher

Driller: Geo-Environmental Drilling, Inc.

Method: Direct Push

Boring:

17 Q 1 of 1

Sheet:

Date:

05/19/98

Location:

Depth (ft)	Lithology	Lithologic Description	Comments	PID	Well Construction
0 		FILL: sand, slag, etc.	boring backfilled with bentonite	<1 ppm	
- 5				< 1 ppm	
10		Bottom of Boring	refusal @ 9.5-feet	< 1 ppm	,
-					
— 15 - -					
- 20					



Environmental Management Consultants

Project: RIDC - M

RIDC - McKeesport McKeesport Commons

Geologist: Von E. Fisher

Driller:

Geo-Environmental Drilling, Inc.

Method: Direct Push

Boring:

17 R 1 of 1

Sheet: Date:

05/19/98

Location:

r	·		,	*************	
Depth (ft)	Lithology	Lithologic Description	Comments	PID	Well Construction
- 0		FILL: sand, slag, etc.	boring backfilled with bentonite	<1 ppm	
_ _ 5				< 1 ppm	
		Bottom of Boring	refusal @ 6.5-feet		,
10 					
<u> 15</u>					



Environmental Management Consultants

Project:

RIDC - McKeesport

McKeesport Commons

Geologist: Von E. Fisher

Driller:

Geo-Environmental Drilling, Inc.

Method:

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Boring:

17 S 1 of 1

Sheet:

Date:

05/19/98

Location: I

Depth (ft)	Lithology	Lithologic Description	Comments	PID	Well Construction
- - 0 -		FILL: sand, slag, etc.	boring backfilled with bentonite	< 1 ppm	
- 5				<1 ppm	
- 10				< 1 ppm	:
		Bottom of Boring	stopped @ 12-feet		
- 15 -					
20					



Environmental Management Consultants

Project: RIDC - McKeesport

McKeesport Commons

Geologist: Von E. Fisher

Driller:

Geo-Environmental Drilling, Inc.

18 B 1 of 1

Sheet: Date:

Boring:

05/20/98

Refer to Figure 3-2 Location:

Method: **Direct Push**

Depth (ft)	Lithology	Lithologic Description	Comments	PID	Well Construction
- 0		FILL: slag, sand, cinders, etc.		< 1	
			boring backfilled with bentonite	ppm	
5				< 1 ppm	
-					
			slight organic odor from 11 to 12- feet	< 1 ppm	
<u> </u>		SILT: clayey, orange brown, moist, some olive gray	VOC sample colledcted from 11.5- feet		
_		Bottom of Boring	stopped @ 12-feet		
- - 15					
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L 20				L	



Environmental Management Consultants

Project: RIDC - McKeesport

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Geologist: Von E. Fisher

Driller:

Geo-Environmental Drilling, Inc.

Method: Direct Push

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18 R 1 of 1

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Sheet: Date:

Location:

05/20/98 Refer to Figure 3-2

€					
Depth (ft)	Lithology	Lithologic Description	Comments	PID	Well Construction
- - -		FILL: slag, sand, cinders, etc.	boring backfilled with bentonite	< 1 ppm	
- 5				< 1 ppm	
- 10				< 1 ppm	
		Bottom of Boring	stopped @ 12-feet		
				The state of the s	
15 					
-				T TOTAL STATE	
_ 20					



Environmental Management Consultants

Project: RIDC - McKeesport

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Geologist: Von E. Fisher

Driller:

Geo-Environmental Drilling, Inc.

Method: **Direct Push** Boring: 18 S

1 of 1

05/20/98

Date:

Sheet:

Refer to Figure 3-2 Location:

Depth (ft)	Lithology	Lithologic Description	Comments	PID	Well Construction
- 0 -		FILL: cinders, slag, sand, etc.	boring backfilled with bentonite	< 1 ppm	
_ 5				< 1 ppm	
- - - 10				< 1 ppm	
_		Bottom of Boring	refusal @ 11.5-feet		
_	3				
<u> </u>					
-					

_ 20					



Environmental Management Consultants

Project: RIDC - McKeesport

McKeesport Commons

Geologist: Von E. Fisher

Driller:

Geo-Environmental Drilling, Inc.

Method: Direct Push

Boring: 19 B

Sheet: 1 of 1

05/20/98

Date: Location:

Depth (ft)	Lithology	Lithologic Description	Comments	PID	Well Construction
- o		FILL: sand, slag, cinders, etc.	boring backfilled with bentonite	< 1 ppm	
_ 5				< 1 ppm	
- 10				< 1 ppm	
		Bottom of Boring	stopped @ 12-feet		
— 15 -					
20					



Environmental Management Consultants

Project:

RIDC - McKeesport

McKeesport Commons

Geologist: Von E. Fisher

Driller:

Geo-Environmental Drilling, Inc.

Method: **Direct Push** Boring:

19 B 1 of 1

Sheet: Date:

05/20/98

Location:

Depth (ft)	Lithology	Lithologic Description	Comments	PID	Well Construction
- 0 -		FILL: sand, slag, cinders, etc.	boring backfilled with bentonite	<1 ppm	
_ _ 5				< 1 ppm	
- - - 10				<1 ppm	
		Bottom of Boring	stopped @ 12-feet		
— 15 -					
20					



Environmental Management Consultants

Project:

RIDC - McKeesport **McKeesport Commons**

Geologist: Von E. Fisher

Driller:

Geo-Environmental Drilling, Inc.

Boring:

1 of 1

19 Q

Sheet: Date:

05/20/98

Location: Refer to Figure 3-2 Method: **Direct Push**

Depth (ft)	Lithology	Lithologic Description	Comments	PID	Well Construction
- O		FILL: sand, slag, cinders, etc.	boring backfilled with bentonite	< 1 ppm	
- 5		Bottom of Boring	refusal @ 7-feet	<1 ppm	
- 10		·			
- 15					
20					



Project:

Driller:

RIDC - McKeesport

McKeesport Commons

Geologist: Von E. Fisher

Geo-Environmental Drilling, Inc.

Boring: Sheet: 19 R 1 of 1

Date:

05/20/98

Location:

Refer to Figure 3-2

Environmental Management Consultants

Method: Direct Push

Depth (ft)	Lithology	Lithologic Description	Comments	PID	Well Construction
- - 0 -		FILL: slag, sand, bricks, etc.	boring backfilled with bentonite	< 1 ppm	
5				< 1 ppm	
- 10				<1 ppm	
-		Bottom of Boring	stopped @ 12-feet		
- - 15					
,					
_ 20					



Environmental Management Consultants

Project: RIDC -

RIDC - McKeesport McKeesport Commons

Geologist: Von E. Fisher

Driller:

Geo-Environmental Drilling, Inc.

Method:

Direct Push

Boring:

20 C 1 of 1

Sheet: Date:

05/20/98

Location:

Depth (ft)	Lithology	Lithologic Description	Comments	PID	Well Construction
- o -		FILL: sand, slag, cinders, etc.	boring backfilled with bentonite	< 1 ppm	
_ 5 _		CLAY: silty, moist, orange brown	wet at 6.5-foot interface	< 1 ppm	
_ 10				< 1 ppm	
		Bottom of Boring	stopped @ 12-feet		
— 15 - -					
_ _ _ 20					



Environmental Management Consultants

Project:

RIDC - McKeesport **McKeesport Commons**

Geologist: Von E. Fisher

Driller:

Geo-Environmental Drilling, Inc.

Method:

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Boring: 20 L

Sheet:

1 of 1

Date:

05/20/98

Refer to Figure 3-2 Location:

	Depth (ft)	Lithology	Lithologic Description	Comments	PID	Well Construction
	0		FILL: sand, slag, cinders, etc.	boring backfilled with bentonite	< 1 ppm	
	5				< 1 ppm	
	10				< 1 ppm	
1	15		SILT: clayey with some slag, orange brown, moist		<1 ppm	
	:0		Bottom of Boring	stopped @ 16-feet		



Environmental Management Consultants

Project: RIDC - Mc

RIDC - McKeesport

McKeesport Commons

Geologist: Von E. Fisher

Driller:

Geo-Environmental Drilling, Inc.

Method:

Direct Push

Boring:

20 R 1 of 1

Sheet: Date:

05/20/98

Location:

Depth (ft)	Lithology	Lithologic Description	Comments	PID	Well Construction
- 0 -		FILL: cinders, sand, slag, etc.	boring backfilled with bentonite	< 1 ppm	
_ _ 5				< 1 ppm	
- - - 10				< 1 ppm	
-		Bottom of Boring	stopped @ 12-feet	-	
15 -					
- - 20					

SOIL COVER OPERATION AND MAINTENANCE PLAN INDUSTRIAL CENTER OF MCKEESPORT

1.0 GENERAL

This Soil Cover Operation and Maintenance (O&M) Plan details the activities to be performed to ensure that the direct contact soil pathway elimination activities that have been or are to be performed at the site pursuant to Pennsylvania Act 2 remain effective over time. This Plan applies to areas where soil cover is used for pathway elimination, as well as for areas where pavement (asphalt or concrete) is used.

2.0 SOIL COVER MAINTENANCE

2.1 Erosion Control

The integrity of the soil cover layer shall be maintained by making repairs whenever erosion gullies greater than 6 inches in depth created by excessive surface water runoff are observed. The gullies shall be repaired by filling the areas to the original grade with material similar to the existing soil cover material. The replacement fill material shall not be taken from other areas of the Industrial Center of McKeesport site without the prior approval of the RIDC's environmental manager. The fill shall be compacted to an equal or greater density than the existing soil cover material.

The erosion potential of the soil cover materials will be evaluated on a continual basis, as detailed in Section 4.0 of this Plan. If continual erosion is observed, erosion control materials such as jute matting or other forms of erosion protection may be employed.

Additionally, any silt fencing or straw bale barriers which are installed shall be inspected to ensure the erosion control measures are performing adequately. Any sections of silt fence or straw bale barrier undermined or topped must be immediately replaced.

2.2 Intrusive Activities

Intrusive activities must follow the requirements of the Soil Management Plan for the Industrial Center of McKeesport. Any damage to the soil cover layer resulting from intrusive activities (drilling, trenching, etc.) shall be repaired immediately upon completion of the activity. The damaged areas shall be repaired by filling the areas to the original grade with material similar to the existing soil cover material. The fill shall be compacted to an equal or greater density than the existing cover material.

2.3 Drainage Structures

Drainage structures (ditches, etc.) conveying stormwater runoff from or around the soil cover shall be inspected annually to ensure the integrity of the structures and eliminate any tendencies for water ponding.

2.4 Vegetation Control

The soil cover vegetation shall be mowed on a regular basis to keep the height of the vegetation cover to a targeted maximum of 12 inches. Deep-rooted plants such as tree seedlings may be removed if the plant is not conducive to the long-term use of the area. Repaired areas and areas devoid of vegetation or more than 50% bare soil shall have topsoil reapplied, followed by application of a nitrogen-rich fertilizer and seed.

2.5 Burrowing Animals

Burrowing animals shall be removed and any holes filled with material similar to the existing soil cover material. The area shall be seeded once the holes have been filled.

2.6 Road Maintenance Practices

Any haul roads or access roads located on the soil cover layer shall be maintained and properly constructed so as to provide a dust-free surface and prevent rutting of the soil cover layer.

3.0 PAVEMENT MAINTENANCE

Pavement that is used for pathway elimination purposes must be maintained in a manner such that it is effective in preventing direct contact with the underlying soils. In the event that the pavement layer is heavily deteriorated or is removed, the cover must be re-established by the installation of new pavement or a layer of soil cover.

4.0 MONITORING

4.1 General

A continual monitoring program will ensure that appropriate maintenance procedures are being implemented for the soil cover layer.

4.2 Monitoring Practices

- Monitor the soil cover layer annually to inspect for gullies and other signs of erosion.
- Monitor any intrusive field activities for damage to the soil cover layer.
- Monitor the placement of materials to repair eroded or otherwise damaged areas within the soil cover layer.
- Monitor seeding and other construction operations associated with the establishment of vegetation.
- Monitor construction, demolition, or other related site activities with the potential for soil cover layer damage.

SOIL MANAGEMENT PLAN INDUSTRIAL CENTER OF MCKEESPORT

1.0 General

This Soil Management Plan describes the excavation, stockpiling, backfilling, revegetation, and environmental control procedures to be implemented when intrusive work such as trenching, excavating test pits, drilling, or other soil disturbance work is to be performed at the Industrial Center of McKeesport site. The Soil Management Plan is intended to provide a standard approach to be used by the property owner, tenants, and subcontractors that is consistent with a risk reduction strategy pursuant to Pennsylvania's Act 2. Potential exposures to soils at the Industrial Center of McKeesport site are or will be addressed by pathway elimination through the use of soil covers. The protocols detailed herein are to be followed in the event that the soil cover (expected to consist of either asphalt/concrete pavement or soil) is disturbed during future redevelopment or site maintenance activities.

2.0 Excavation and Stockpiling

Prior to performing any intrusive work, the location and extent of any soil cover layer in the vicinity of the proposed work shall be verified and delineated to allow proper excavation and segregation of the cover soil material from the underlying soils or those soils not covered. All overhead and underground utilities shall be located and all utility clearance requirements shall be met prior to commencing any excavation activities.

The excavation shall be performed using standard excavation equipment such as a backhoe or excavator. When intrusive work is being performed in areas where soil has been used as the soil cover material, personnel shall visually check the material being excavated to determine when the bottom of the cover soil has been reached. All excavations shall be sloped or shored in accordance with OSHA regulations. Additionally, safety fence shall be installed around the perimeter of all open excavations if the excavations will not be immediately backfilled.

The locations of the soil stockpiles shall be delineated and appropriate erosion and sediment control measures (i.e. silt fence, straw bales) shall be installed downslope of the excavation area and stockpile areas. The soil stockpiles shall be located adjacent to the excavation area or at an alternative approved area. Cover soil material shall be stockpiled separately from any soils from beneath the cover soils (underlying soils) which are excavated. Where the delineation of stockpiled material and the existing ground surface cannot be readily distinguished, the excavated underlying soils shall be placed on a marker layer (such as a geotextile fabric) to provide such a distinction between the excavated soils and ground surface. The stockpiled underlying soils shall be covered with a tarp until subsequently managed, or until any sampling that is performed demonstrates that the soil quality meets applicable standards.

3.0 Testing

For excavation projects where the volume of excavated material will exceed 100 cubic yards, or where uncharacteristic materials (i.e. other than slag or natural soils) are encountered, a

representative sample of the total volume of excavated soils shall be collected and analyzed to determine if the soils should be classified as a characteristic hazardous waste. In the event that the materials are classified as characteristic hazardous waste, they shall be appropriately managed and disposed in an approved off-site location.

4.0 Backfilling

Prior to backfilling excavated soils, all ponded water within the excavation shall be managed in an appropriate manner. The excavated soils shall be backfilled by placing the soils in appropriate lifts and compacting with approved equipment until nonmovement of the material is observed beneath the compaction equipment during compaction operations. After underlying soils have been backfilled, the cover soil material shall be backfilled and compacted in a similar manner to the underlying soils and graded to the approximate pre-excavation grades.

5.0 Revegetation

Following completion of the backfilling and grading operations, the disturbed areas shall be properly seeded and mulched to establish vegetative growth, unless pavement is to be used as the final soil cover material. Seeding and mulching materials and procedures shall be in accordance with Sections 804 and 804 of the Commonwealth of Pennsylvania Department of Transportation Specifications, 1994. Once an adequate stand of vegetation is established, all installed erosion and sediment control measures shall be removed.

6.0 Environmental Controls

6.1 Dust Control

During excavation, stockpiling and backfilling activities, appropriate actions shall be taken to minimize dust emissions from the work area and soil stockpiles. Water for dust suppression shall be obtained from an approved source and shall be used as needed. Additionally, tarps may be used to cover soil stockpiles to protect the soil stockpiles from wind and minimize dust emissions.

6.2 Stormwater Management

Depending on the size and extents of the excavation, it may be necessary to construct temporary drainage ditches or berms to divert stormwater surface water runoff from the excavation and soil stockpile areas. Temporary ditches and berms shall be constructed as indicated in the Pennsylvania DEP *Erosion and Sediment Pollution Control Program Manual*.

6.3 Erosion and Sediment Control

Erosion and sediment control measures shall consist of the installation and maintenance of silt fence and/or straw bales, as necessary, for the duration of the construction activities. Silt fence and/or straw bales shall be installed downslope of all areas where excavation activities are to be performed or stockpiles are to be located. The silt fence and/or straw bale barriers shall be installed and maintained as indicated in the Pennsylvania DEP *Erosion and Sediment Pollution Control Program Manual*.

6.4 Equipment Decontamination

All equipment used to excavate and backfill any material other than cover soil shall be properly decontaminated prior to demobilization from the site.

6.5 Health and Safety

Prior to initiating intrusive work at the site, contractors shall prepare a Project Health and Safety Plan that is consistent with the Health and Safety Guidelines that are included as Attachment A. This document shall identify specific personnel responsible for ensuring that the Project Health and Safety Plan is followed.

7.0 Drilling

When drilling is performed at the Industrial Center of McKeesport site, all cuttings shall be collected, contained, sampled, and managed appropriately. All completed boreholes shall be backfilled with a cement/bentonite grout. The grout shall be pumped through a tremie pipe, in one continuous operation, from the bottom to the top of the borehole.

8.0 RECORDKEEPING AND REPORTING

8.1 General

The recording of field activities provides an avenue for review of construction work. The following recordkeeping and reporting procedures shall be followed when intrusive activities are performed at the Industrial Center of McKeesport site.

8.2 Photographic Log

The Site Manager shall be responsible for collecting photographs of any intrusive activities performed at the site. Photographs provide a visual record of intrusive activities performed and site conditions.

Photographs shall be taken of the area where intrusive activities are to be performed to record site conditions prior to any work, record actual intrusive work performed, and record the condition of the site following completion of work after backfilling and revegetation activities have been completed. The photographs shall be dated and identified with location description and a description of the activity photographed.

8.3 Operating Records

The Site Manager shall be responsible for completing Reporting Forms (Attachment B) for each intrusive event. The form shall be completed describing, at a minimum, the activities performed, personnel involved, and dates of the work performed. Photographs shall be attached to the Reporting Form.

ATTACHMENT A Health and Safety Guidelines

HEALTH AND SAFETY GUIDELINES

INDUSTRIAL CENTER OF THE CITY OF McKEESPORT

Prepared for

RIDC SOUTHWESTERN PA GROWTH FUND Pittsburgh, PA

Prepared by:

KU RESOURCES, INC. Duquesne, PA 15110

1.0 SITE BACKGROUND AND SCOPE OF WORK

1.1 ORGANIZATION AND RESPONSIBILITIES

1.1.1 General

This Health and Safety Guideline (HASG) contains the general requirements for protection of onsite personnel during soil disturbance activities at the former USX National Tube Works in McKeesport, Pennsylvania.

The protection of workers and the environment are major concerns during project design and execution and cannot be compromised. The objectives of this HASG are to assure that safe working conditions exist at the site as related to potential exposure to contaminated soils. Procedures have been established based on an analysis of potential hazards, and personnel protection measures have been selected in response to these risks.

The HASG shall be used by contractors to develop a project specific health and safety plan (HASP), which shall be available on-site for inspection and review by all employees, their designated representative, RIDC, and regulatory personnel.

The HASG and all activities conducted at the site shall be, in compliance with applicable sections of the following documents:

- 29 CFR 1926, OSHA Construction Industry Standards;
- 29 CFR 1910, OSHA General Industry Standards;
- 40 CFR Subchapter R, Toxic Substances Control Act; and
- Rules and Regulations of the Allegheny County Health Department

1.1.2 <u>Site Health and Safety Officer</u>

A Site Health and Safety Officer (SHSO) will be required. He/she will be responsible for the field coordination of the project HASG. Among the specific duties of the SHSO are: hazard assessment, air monitoring, evaluation of the personal protection equipment program, and consulting with other Health and Safety personnel on matters related to the project. The SHSO reports to the Project Manager, and has authority to stop work when necessary to guarantee employee wellbeing.

1.1.3 Site Workers

All site personnel are responsible for continuous adherence to the HASG during the performance of the work. In no case may work be performed in a manner that conflicts with the intent of, or the inherent safety precautions expressed in this HASG. After due warnings, personnel continuing to violate the requirements of this HASG will be dismissed from the site.

1.2 SITE BACKGROUND

The National Tube Works was a large-scale manufacturer of steel tube and pipe and served as the main plant of the US Steel eastern tubular operations. Operations present at the facility included blast furnaces, open hearths, blooming mills, rolling mills, seamless mills, a submerged arc weld mill, and an electric resistance weld mill. Significant contaminates that may exist at the facility include: waste corrosives, heavy metals, waste petroleum products and PCBs. Excavation activities at the Site pose physical hazards and excavated materials may be contaminated with low levels of these hazardous materials.

1.3 SCOPE OF WORK

This HASG was developed to address the potential contaminant exposure hazards to personnel performing the following generalized scope of work. This HASG does not cover the physical hazards associated with excavation such as working in excavations, shoring, and trenching.

- Disturbance and management of potentially contaminated surface and subsurface soils.
- Construction activities associated with exposure to contaminants within excavations.

Most of the hazards anticipated will occur during the excavation and handling activities although exposure may take place during construction oversight. Physical hazards will be continually present in the construction activities.

2.1 SITE EVALUATION

The performance of excavation and/or drilling activities at the site presents the potential of exposure to chemical hazards. Of the potential chemical exposure hazards present at the site, the following list includes those considered at this time to be the most significant.

Chemical Hazards

Potential hazards exist from employee exposure to the following residual substances that may be present in subsurface soils:

- Polychlorinated Biphenyls (PCBs);
- petroleum hydrocarbons;
- heavy metals (lead, chrome, cadmium);
- residual polyaromatic hydrocarbons (PAHs);
- corrosives (acids and caustics);
- crystalline silica (refractory materials);
- cyanide and sulfide wastes; and
- volatile organic compounds (VOC).

The standard level of protection for work on this project is Level D, consisting of:

- Hardhat,
- Safety shoes.
- Safety glasses with permanent side shields,
- Long pants and long-sleeve shirt, and
- Canvas or leather work gloves.

3.0 EMPLOYEE TRAINING/HAZARD COMMUNICATION CONSIDERATIONS

3.1 FORMAL TRAINING

All personnel who enter the authorized area shall have completed training equivalent to the requirements set forth in 29 CFR 1910 and 1926. If any of the anticipated work involves hazardous waste operations, site personnel will be required to have 40 hours of formal off-site training and subsequent 8 hours annual refresher training. Supervisors will possess an additional 8 hours of supervisory training.

3.2 SITE-SPECIFIC TRAINING

Before beginning field operations, each employee assigned to this project should attend a health and safety training session. The following topical outline should be used to develop the pertinent issues of concern to be incorporated into the training session.

Project Scope of Work

- Work area orientation
- Work activities
- Key personnel and visitors
- Regulatory agencies

Health and Safety Program

- Contractor Health and Safety Plan
- Site Health and Safety Guideline

Role of Project Health and Safety Coordinator/Site Manager

- Duties and authority
- Compliance with safety rules

Hazardous Substance Information

- Contaminants known or suspected (by area)
- Routes of exposure based on work activities
- Effects of exposure
 - -- Physiological warning signs

- -- Acute vs. chronic-latent effects
- -- Dose-response relationship

Hazard Control Program

- Restricted access areas
- Personal protective equipment
- Air monitoring
- Rules and procedures
- Personal hygiene

Use of Protective Equipment

- Personal protective clothing
 - Protective equipment combinations
 - -- Limitations of use
- Respiratory protective equipment
 - -- Air purifying
 - Supplied air
 - Selection, donning, fit and use
 - Cleaning and maintenance
- Decontamination of clothing and equipment
- Disposal of contaminated clothing and equipment

First Aid and Safety Equipment

- Identification of personnel trained in first aid/CPR
- First aid equipment
- Fire extinguishers

Eye wash stations and emergency showers

Emergency Contacts and Response Procedures

- Telephone contacts for assistance
- Reporting responsibilities
- Evacuation procedures
- Accident/injury response
- Basic Life Support and First Aid Procedures

The training session will be documented by obtaining the signature of each participant. No person will be allowed to work in areas covered by the Soil Management Plan without completing the orientation program and signing the roster.

3.3 MATERIAL SAFETY DATA SHEETS

General chemical information in the form of MSDSs for residual or waste materials encountered on site shall be included in the HASP.

4.0 SITE CONTROL CONSIDERATIONS

4.1 ACCESS

Access to the site is through existing plant gates. Security personnel are stationed at these gates. No other means of access are authorized for use.

4.2 BUDDY SYSTEM/COMMUNICATION

All personnel shall follow the "buddy system" when inside the authorized area. Two-way radio communications shall be available between the project office and the site teams.

4.3 POSTING

The sites should be posted to warn of potential hazards. Also, notices regarding the use of protective equipment (hardhats, safety glasses, etc.) should be placed at the access points to the sites. Additional notices of specific hazardous areas should be posted where needed.

4.4 VISITORS

Visitors to the site shall sign in at the guard station. They shall be advised of the potential hazards at the site, and be provided with a copy of the site safety rules. Visitors shall be escorted at all times while inside the authorized area.

ATTACHMENT B

REPORTING FORM

REPORTING FORM

NAME:
DATES OF WORK PERFORMED:
PERSONNEL ON SITE:
DETAILED DESCRIPTION OF WORK PERFORMED:
WERE EROSION AND SEDIMENT CONTROLS PROPERLY INSTALLED? IF "NO" EXPLAIN:
WAS AREA PROPERLY BACKFILLED AND REVEGETATED? IF 'NO' EXPLAIN:
Attached: Photographs

Analytical Laboratory Results

Site Manager cc: Plant File

BUSINESS INNOVATION CENTER, SUITE 207 ONE LIBRARY PLACE DUQUESNE, PA 15110 (412) 469-9331 FAX (412) 469-9336

CERTIFIED MAIL RETURN RECEIPT REQUESTED

April 5, 2000

The Honorable Wayne Kucich Mayor City of McKeesport 201 Lysle Boulevard McKeesport, PA 15132

Subject: Industrial Center of McKeesport (Former National Tube Works)

McKeesport, Allegheny County, Pennsylvania

Dear Mayor Kucich:

The Land Recycling and Environmental Remediation Standards Act (Act 2) requires that a Notice of Intent to Remediate (NIR) a site be provided to the municipality in which the site is located. In accordance with this provision of Act 2, and on behalf of the RIDC of Southwestern Pennsylvania Growth Fund (RIDC), we are notifying you of the intent to remediate the subject site. A copy of the NIR which has been sent to the Department of Environmental Protection (PADEP) is enclosed. A notice will also be published in the Pennsylvania Bulletin, and a summary of the notice will be placed in the McKeesport Daily News, April 7, 2000 edition. A copy of this summary is attached. Please send any comments the City may have on the attached NIR to my attention at KU Resources, Inc., One Library Place, Suite 207, Duquesne, PA 15110.

Notice is hereby also given that RIDC intends to withdraw a previous NIR submitted to PADEP which covered only the Powerhouse Area at the site. This area has been incorporated into this new NIR.

Additionally, notice is given that the RIDC intends to submit a final report to the PADEP for the site on or about May 8, 2000 upon expiration of the public comment period. The report indicates that, upon redevelopment, the site will attain the Site-Specific cleanup standard under Act 2.

Publication of this Notice in the McKeesport Daily News initiates the 30-day public and municipal comment period, during which the City may request to become involved in the development of a formal public participation program for the site. If the City wishes to request such a program, please send a notice to my attention.

This notice is made under the provision of the Land Recycling and Environmental Standards Act, the Act of May 19, 1995, P.L. 4, No. 2.

Should you have any questions or comments regarding the proposed remediation, please contact the undersigned on (412) 469-9331.

Very truly yours,

Mark Urbassik, PE, JD

Principal

KU Resources, Inc.

MU:su

Attachment

C:

Maureen Ford, RIDC Charles Starrett, RACM

Business Innovation Center, Suite 207
One Library Place
Duquesne, PA 15110
(412) 469-9331
Fax (412) 469-9336

CERTIFIED MAIL RETURN RECEIPT REQUESTED

April 5, 2000

Mr. John J. Matviya
Environmental Cleanup Program Manager
Southwest Regional Office
Pennsylvania Department of Environmental Protection
400 Waterfront Dr.
Pittsburgh, PA 15222-4745

Subject: Industrial Center of McKeesport

(Former National Tube Works)

McKeesport, Allegheny County, Pennsylvania

Dear Mr. Matviya:

Please find attached duplicate copies of the Notice of Intent to Remediate (NIR) for the Industrial Center of McKeesport. This NIR is being submitted on behalf of the RIDC of Southwestern Pennsylvania Growth Fund (RIDC). A copy of the NIR, this letter, and the legal notice which will be published in the McKeesport Daily News on April 7, 2000, have been transmitted to the Mayor of McKeesport.

With the filing of this NIR, RIDC is withdrawing a previously submitted NIR of a portion of the site referred to as the Power House area (LRP No. 5-2-112-8837). This area has been incorporated into the reports which will be submitted pursuant to the attached NIR.

Any questions you may have with regard to this letter or the attached NIR should be directed to the undersigned. I look forward to reaching a mutually satisfactory conclusion to this project.

Very truly yours,

Mark Urbassik, PE, JD

Principal

KU Resources, Inc.

MU:su

Attachment

c: Maureen Ford, RIDC

COMMONWEALTH OF PENNSYLVANIA DEPARTMENT OF ENVIRONMENTAL PROTECTION BUREAU OF LAND RECYCLING AND WASTE MANAGEMENT

NOTICE OF INTENT TO REMEDIATE

Name Industrial Center of McKeesport						
Site	AddressL	ysle Boulevard				
Loca	tion					
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	Lead	SSS	SSS	SSS		
	Heavy Metals	SSS	SSS	SSS	American and the control of the cont	
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nticip	ated Future Use:	Residential F	Recreational A	gricultural		
	n-Residential Industrial X Commercial X					

-	EAA	CAA.I	RWW0019	10/97
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Anticipated Date of Submission of Plan or Final Repo	ort Combined SSS	Report - May 1, 2000
Name of newspaper and date of publication of NIR Su		cKeesport Daily News
Ownership History (for Special Industrial Areas only):		
Proposed Remediation: Site assessment activities have demonstrated pathway elimination through groundwasoil covers will attain the SSS under	ater use restri	
Benefits of Future Use: Redevelopment of a significant parce provide multiple opportunities for j significantly impacted by the decline Mon Valley.	obs and econom:	ic growth in an area
RIDC of Southwestern Property Owner Name Growth Fund		Suite 500, 425 Sixth Ave Pittsburgh, PA 15219
Remediator Name Same Provide copy of NIR to owner if different than remediator.		Same
Preparer of Notice of Intent to Remediate:		
Name Mark Urbassik	Title Principal	- KU Resources, Inc.
Address One Library Place, Suite 207,	Duquesne, PA	15110
Signature Muh Maril	Date 4500	Telephone <u>412-469-93</u> 3 Z

LEGAL NOTICE

Pursuant to the Land Recycling and Environmental Remediation Standards Act, the Act of May 19, 1995, P.L. 4, No. 1995-2, notice is hereby given that the RIDC of Southwestern Pennsylvania Growth Fund and KU Resources Inc. have submitted to the Pennsylvania Department of Environmental Protection a Notice of Intent to Remediate the Industrial Center of the City of McKeesport (formerly the United States Steel Corporation National Tube Works), located between Lysle Boulevard and the Allegheny River in McKeesport, Allegheny County, Pennsylvania. This Notice of Intent to Remediate states that the former steel manufacturing facility contains soils which have been found to contain elevated levels of metals and organic compounds deposited as result of the site's historical use. The RIDC of Southwestern Pennsylvania Growth Fund and KU Resources Inc. have indicated that the level of remaining materials will meet the Pennsylvania Department of Environmental Protection's Site Specific Standard and, other than the placement and maintenance of a soil cover, no further remediation will be necessary. The proposed future use of the property will be non-residential for light industrial or commercial use.

Notice is also hereby given that RIDC of Southwestern Pennsylvania Growth Fund intends to withdraw a previous Notice of Intent to Remediate submitted to the Pennsylvania Department of Environmental Protection pursuant to the Land Recycling and Environmental Remediation Standards Act on February 10, 1997, in association with a portion of the Industrial Center of the City of McKeesport designated as the Powerhouse Area (LRP No. 5-2-112-8837). The Powerhouse Area has been incorporated into the Industrial Center of the City of McKeesport and the Notice above now covers this area. The collective property shall be referred to as the Industrial Center of the City of McKeesport.

Notice is also hereby given that the RIDC of Southwestern Pennsylvania Growth Fund and KU Resources Inc. intend to submit a combined Remedial Investigation and Risk Assessment report to the Pennsylvania Department of Environmental Protection Southwest Regional Office, which demonstrates attainment of the Site-Specific Standard for the site and details the exposure pathways elimination that will be taken. The combined report will be submitted on or about May 8, 2000, upon expiration of the public comment period. The RIDC of Southwestern Pennsylvania Growth Fund and KU Resources, Inc. have indicated that the planned site development work and the risk assessment demonstrate that the Site Specific cleanup standard established under the Land Recycling and Environmental Remediation Standards Act will be met with no additional remediation required.

This notice is made under the provision of the Land Recycling and Environmental Remediation Standards Act, the Act of May 19, 1995, P.L. #4, No. 2.

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	Receipt for Certified Mail			
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6. Signature; (Addressee or Agent)		
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CERTIFIED MAIL RETURN RECEIPT REQUESTED

June 16, 2000

The Honorable Wayne Kucich Mayor City of McKeesport 201 Lysle Boulevard McKeesport, PA 15132

Subject: Industrial Center of McKeesport (Former National Tube Works)

McKeesport, Allegheny County, Pennsylvania

Dear Mayor Kucich:

The Land Recycling and Environmental Remediation Standards Act (Act 2) requires that a notice to the Municipality be sent when a Remedial Investigation, Risk Assessment, or Cleanup Plan report is submitted to the Department of Environmental Protection (PADEP). Notice is hereby given that the RIDC intends to submit a combined Remedial Investigation, Risk Assessment, and Cleanup Plan report to the PADEP for the subject site on June 23, 2000. The report indicates that, upon redevelopment, the site will attain the Site-Specific cleanup standard under Act 2. We had previously thought that the report would be submitted around May 8, 2000. A summary of the notice will be placed in the McKeesport Daily News, June 19, 2000 edition. A copy of this summary is attached. Please send any comments the City may have on the attached notice to my attention at KU Resources, Inc., One Library Place, Suite 207, Duquesne, PA 15110.

This notice is made under the provision of the Land Recycling and Environmental Standards Act, the Act of May 19, 1995, P.L. 4, No. 2.

Should you have any questions or comments regarding the proposed remediation, please contact the undersigned on (412) 469-9331.

Very truly yours,

Mark Urbassik, PE, JD

Principal

KU Resources, Inc.

MU:su Attachment

Maureen Ford, RIDC Charles Starrett, RACM

LEGAL NOTICE

Pursuant to the Land Recycling and Environmental Remediation Standards Act, the Act of May 19, 1995, P.L. 4, No. 1995-2, notice is hereby given that the RIDC of Southwestern Pennsylvania Growth Fund and KU Resources Inc. will submit the combined Remedial Investigation, Risk Assessment, and Cleanup Plan report to the Pennsylvania Department of Environmental Protection Southwest Regional Office, which demonstrates attainment of the Site-Specific Standard for the site and details the exposure pathways elimination that will be taken. The combined report, which was previously intended to be submitted on or about May 8, 2000, will, in fact, be submitted on or about June 23, 2000. The RIDC of Southwestern Pennsylvania Growth Fund and KU Resources, Inc. have indicated that the planned site development work and the risk assessment demonstrate that the Site Specific cleanup standard established under the Land Recycling and Environmental Remediation Standards Act will be met with no additional remediation required.

This notice is made under the provision of the Land Recycling and Environmental Remediation Standards Act, the Act of May 19, 1995, P.L. #4, No. 2.

U.S. Postal Service CERTIFIED MAIL RECEIPT (Domestic Mail Only; No Insurance Coverage Provided)
Why Mayor McKensport
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Return Receipt Fee (Endorsement Required) Restricted Delivery Fee (Endorsement Required)
Total Postage & Fees \$ 2 98 USPS Recipient's Name (Please Print Clearly) (to be completed by mailer)
Street, Apr) Soc. or Ro Fox /9 1 100 City, State, 219: 100 15137 PS Form 3800, February 2000 See Reverse for Instructions

	SENDER: Complete items 1 and/or 2 for additional services. Complete items 3, 4a, and 4b. Print your name and address on the reverse of this form so that value and to you.		following services (for an extra fee):	ė,
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SOIL ASSESSMENT PROGRAM SUMMARY REPORT

INDUSTRIAL CENTER OF McKEESPORT McKEESPORT, PENNSYLVANIA

Prepared for

RIDC SOUTHWESTERN PENNSYLVANIA GROWTH FUND

Prepared by

ICF KAISER ENGINEERS, INC. Pittsburgh, Pennsylvania 15219



January 1997

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EXECUTIVE SUMMARY

In the capacity of Environmental Consultant to the RIDC Southwestern Pennsylvania Growth Fund (Growth Fund), ICF Kaiser Engineers, Inc. (ICF Kaiser) has developed and implemented a soil sampling program to characterize the quality of the soils within a defined parcel of land (the Site) at the Industrial Center of McKeesport (ICM). The objectives of this report are to summarize the analytical data obtained, evaluate potential impacts to human health, and develop recommendations based on the findings of the investigation.

CONCLUSIONS

The following conclusions can be drawn from the data and intended use of the Site:

- 1. Only three constituents (lead, vanadium, and naphthalene) are present in the soil at concentrations in excess of Industrial MSCs.
- 2. A baseline risk assessment determined that the soil will have no adverse effect or human health.
- 3. No further remedial action is necessary under the current land use scenario given the constituent levels present in the soil at the Site.

BACKGROUND INFORMATION

The ICM is located on Lysle Boulevard in McKeesport, Pennsylvania (see Figures 1-1 and 1-2). The ICM is bordered on the north by the Monongahela River, the east by property of the Dravo Corporation, the south by Lysle Boulevard, and the west by the Youghiogheny River.

The history of the ICM dates back to the 1870 purchase of the Fulton-Bolman Company by the Flagler Company. Throughout the 1900s, the National Plant (ICM) produced steel tube and pipe as part of the United States Steel Corporation (USS, now USX). The National Plant was shut down in 1987, and property ownership was transferred to Allegheny County in 1989. In 1990, the Growth Fund began preparing the ICM for redevelopment as an industrial park.

SOIL ASSESSMENT PROGRAM

The primary objectives of this investigation were to characterize the quality of soil at the Site and determine the potential impact to human health. ICF Kaiser evaluated historical information and established three Areas of Concern (AOCs) at the Site: the Electric Repair Shop and Powerhouse; the Pipe Storage building; and the Walker Tickener Area. Additional random sampling was performed across the Site outside of the AOCs.

MAJOR FINDINGS

ICF Kaiser collected soil samples to a depth of six inches for analysis of aromatic hydrocarbons, polychlorinated biphenyls (PCBs), metals, and cyanide. The analytical data obtained were compared to Pennsylvania Act 2 Media-Specific Concentrations (MSCs) for soils at non-residential sites. Only three parameters were present at concentrations exceeding their respective MSCs, lead, vanadium and naphthalene.

93135-890-T

Lead exceeded its MSC at the Electric Repair Shop and Powerhouse at two locations. At the Pipe Storage building, naphthalene exceed its MSC at one location. In the Walter Thickener Area, MSCs were exceeded for lead (three locations) and vanadium (one location). Lead exceeded its MSC in one random sample location, which was adjacent to the Walker Thickener Area.

RISK ASSESSMENT

A baseline risk assessment was performed in accordance with the Act 2 Technical Guidance. The general approach consisted of the identification of constituents of interest, an exposure assessment, a toxicity assessment, and risk characterization.

Only the three constituents mentioned previously (lead, vanadium, and naphthalene) were identified as constituents of interest. Naphthalene was eliminated as a constituent of interest because the 95% upper confidence limit (UCL) is below the MSC and the data does not indicate that a considerable mass of naphthalene is present in the vadose zone. Vanadium was eliminated as a constituent of interest because the 95% UCL was well below the MSC.

The exposure assessment identified three relevant potential receptors, an adult industrial worker, an adult construction worker, and an older child/teenage trespasser. Also, the routes of exposure were identified, dermal contact and ingestion of soil, and inhalation of fugitive dusts.

The toxicity assessment identified the most sensitive adult receptor to lead, a pregnant woman, and calculated a benchmark soil lead concentration of 2,000 mg/kg, which yields an acceptable blood lead level for a pregnant woman. An alternative model, based on the fetus of a female industrial worker, yielded a target concentration of 11,100 mg/kg.

The conclusions of the risk characterization were that the detected concentrations are within EPA benchmark levels, indicating that adverse health effects from constituents in soil are not likely.

1.0 INTRODUCTION

1.1 PURPOSE

ICF Kaiser Engineers, Inc. (ICF Kaiser) is serving as the RIDC Southwestern Pennsylvania Growth Fund's (Growth Fund) Environmental Consultant for the remedial activities being performed as part of the redevelopment of the Industrial Center of McKeesport (ICM). In this capacity, ICF Kaiser has developed and implemented a soil sampling program to characterize the quality of the soils within a defined parcel of land (the Site) at the ICM.

The primary objective of the soils quality assessment was to further characterize the quality of the soils at the Site and the potential impact it may have on human health.

The specific objectives of this report are to:

- Summarize the analytical data obtained from the investigation performed by ICF Kaiser,
- Evaluate the potential impact that the site soil may have on human health,
- Develop recommendations based on the investigation's findings.

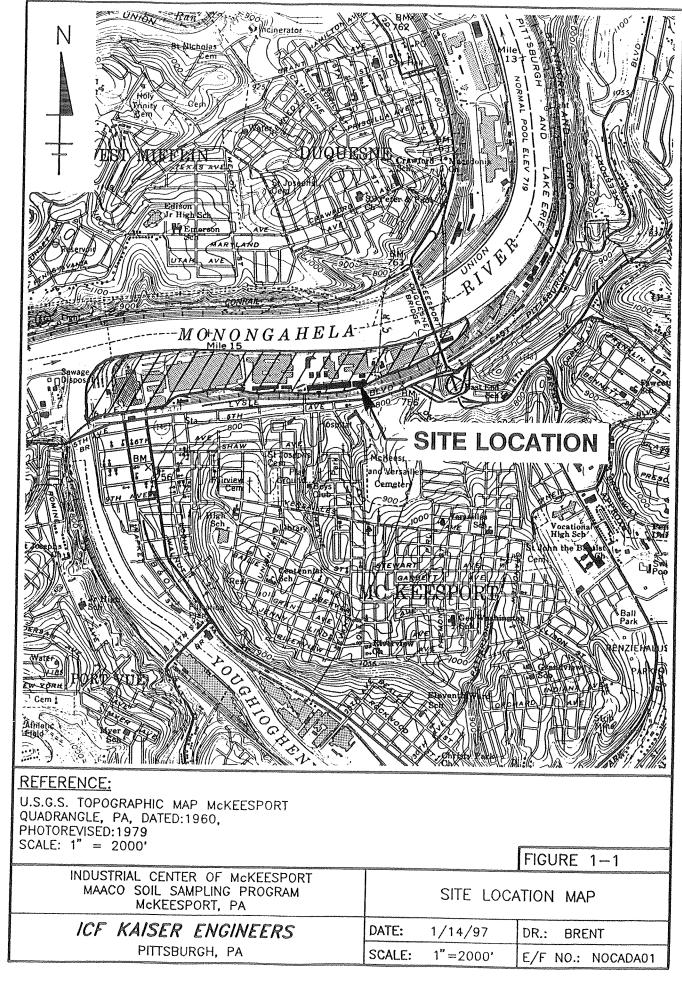
1.2 SITE LOCATION

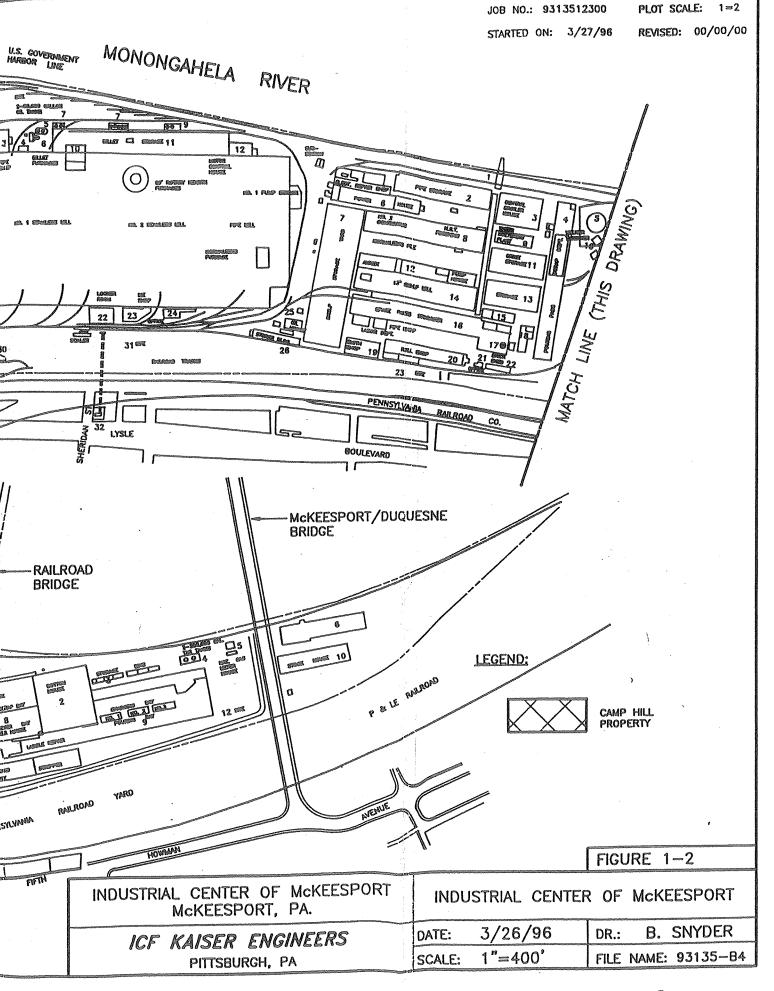
The ICM is located on Lysle Boulevard in McKeesport, Pennsylvania (Figure 1-1), and is approximately 1.3 miles long and 0.16 miles wide (Figure 1-2). The ICM is surrounded on two sides by industrial and commercial properties. The ICM is bordered on the north by the Monongahela River and railroad tracks and on the south by the railroad tracks of the Union-McKeesport Connecting Railroad and Conrail. Located beyond these railroad tracks is Lysle Boulevard, which is lined with businesses and serves as the main thoroughfare through the city's business district. The west end of the ICM is bordered by the Youghiogheny River. The east end of the property is tapered and is bordered by railroad tracks and yards and the property of the Dravo Corporation.

1.3 SITE HISTORY

The history of the ICM dates back to 1870 when the Flagler Company, owned by John H. and Harvey K. Flagler, purchased the partially rebuilt works of the Fulton-Bolman Company in the City of McKeesport. Shortly thereafter the Flagler Company became incorporated as the National Tube Works. In 1899, thirteen major tube and pipe producers, including the National Tube Works, were consolidated and named the National Tube Company. On March 1, 1901, the National Tube Company became a subsidiary of the United States Steel Corporation (USS). Although the site (National Plant) never included a coke plant, it served as the "mother plant" of the USS Eastern Steel Operations' tubular products section for the next 80 years. In 1969, the National Plant was merged with the USS Duquesne Plant located across the Monongahela River.

Following the merger of the two plants, many of the operations at the National Plant were shut down. This included the closing of the Blast Furnaces, Open Hearth, Blooming Mill and Rolling Mill.





All rounds, blooms and bars were then supplied by the Duquesne Plant. The No. 1 Blast Furnace was left in operation and was used in the production of ferro-manganese steel.

Throughout the 1900s, the National Plant produced steel tube and pipe of varying sizes and characteristics to suit the diverse needs of its customers. The Seamless Mill produced pipes ranging in size from 4-1/2" outside diameter to 24" outside diameter. The Submerged Arc Weld Mill, which was built to meet the demands for larger diameter pipe, produced 24" to 36" diameter pipe in 41-foot lengths. Longer length, thinner wall and greater strength pipe was produced by the Electric Resistance Weld Mill. The National Plant was shut down by USX (formerly USS) in 1987 and ownership was transferred to Allegheny County in 1989.

1.4 SITE REDEVELOPMENT

In 1990, the Allegheny County Industrial Development Authority transferred ownership of the 135-acre site to the Growth Fund. In an effort to revitalize the City of McKeesport, create jobs, and promote economic growth, the Growth Fund began preparing the property for redevelopment as an industrial park. This ongoing effort has included:

- The removal and off-site disposal of PCB and PCB-contaminated electrical equipment;
- Removal, decontamination, and off-site disposal of materials from tanks, vessels, equipment and piping;
- Asbestos abatement;
- Staging, removal, transportation and off-site disposal of approximately 2,000 drums;
- Permanent closure (by removal) of eight (8) underground storage tanks;
- Remediation of over one hundred pits and sumps;
- Removal, transportation and off-site disposal of waste piles;
- Renovation of selected existing buildings;
- Building demolition; and
- New infrastructure construction.

1.5 FUTURE USE OF THE SITE

The Growth Fund's main purpose in the redevelopment of the former National Plant is to create jobs, promote economic growth, and return the City of McKeesport to an industrial center. This revitalization will be achieved by leasing parcels of land and renovated buildings to viable industrial and manufacturing clients. The ICM was designated a General Industrial District (Zoning I-1) in 1993 by the City of McKeesport. The land has already been subdivided, and the Growth Fund is currently marketing those remediated parcels to prospective manufacturing and industrial clients. These parcels are permitted for uses such as any manufacturing activity complying with environmental

performance standards; printing and publishing; warehouse or storage facilities; vehicular repair services; and railroad or truck terminals. Other conditional uses for which the land has been approved include research and development facilities, testing laboratories, salvage yards, and warehouse or storage facilities for hazardous materials.

New infrastructure construction has already begun at the Site. One new building, a section of roadway, and a parking lot have been constructed over the former location of the blast furnaces. Several existing structures have been reconditioned and one building currently houses a pressure vessel manufacturing firm. This soil sampling program encompasses a specific, 14-acre, parcel of land (the Site) located approximately between the former Roundhouse and Pipe Mill Buildings. This parcel lies along the recently constructed Industry Road.

In accordance with City of McKeesport regulations on new construction, the ICM will be serviced by the municipal water supply and the municipal sewage treatment plant, thus precluding the use of the ICM groundwater as a drinking water supply.

1.6 PHYSICAL CHARACTERISTICS

1.6.1 Local Topography

Western Pennsylvania, including Allegheny County, is located in the Appalachian Plateaus Province where the rocks at the surface are almost flat-lying and give the topography a generally level surface at an altitude great enough to have permitted deep valley cutting by streams. In Allegheny County the flat hill tops lie at approximately 1,200 feet elevation, with narrow valleys cut 400 to 500 feet below the tops of the hills.

The Monongahela Valley receives alluvium from its drainage area south of Pittsburgh, which is comprised of sedimentary rocks. Consequently, the material deposited in the river valley is fine-grained sand, silt and clay. The more resistant sandstones form the coarse fraction while the shales form the fine fraction of the alluvium. In the vicinity of McKeesport, the alluvium is comprised of alternating beds of sand and clay or of massive sandy/silty clay to a depth of 40 feet below the flood plain. The underlying portion, from 20 to 50 feet in thickness, comprises beds of moderately-sorted sand and gravel. Total thickness of the alluvium would be on the order of 60 to 90 feet. On the Site, the natural flood plain carries an overburden of slag to thickness of as much as 30 feet thick. Total thickness of unconsolidated sediments, natural and artificial, could be as much as 120 feet on the bank of the Monongahela River.

Locally, the hills on both banks of the Monongahela River are rocks of the Conemaugh and Monongahela Formations. The Monongahela Formation is younger than the Conemaugh and is found at higher elevations. Monongahela rocks are very calcareous with shales, sandstones, and coals. The Conemaugh rocks are shales (many red shale beds), sandstones and thin coals. Much of the bedding is discontinuous (Revised from Duncan, Lagnese and Associates, Environmental Assessment Report, 1988).

2.0 SITE INVESTIGATIONS

2.1 OBJECTIVES

The primary objective of ICF Kaiser's investigation at the Site was to characterize the quality of the soil at the Site and the potential impact it may have on human health. To accomplish this objective, ICF Kaiser developed a soil quality assessment that followed the DEP's Environmental Investigative Guidelines for the Phase I and II studies. A Phase II Site Characterization Work Plan (Work Plan) was prepared to document field sampling, sample chain of custody, laboratory analyses, and data reporting procedures. The DEP reviewed the Work Plan and their comments were incorporated in the plan's final version. This section describes the approach to this investigation as well as the procedures used in performing the investigative activities. The results of this investigation are incorporated into the Baseline Risk Assessment presented in Section 4.0.

2.2 APPROACH

The approach to characterize the soil quality at the Site was to build upon and supplement the work performed previously by ICF Kaiser. ICF Kaiser evaluated historical information (Section 2.2.1) in order to establish Areas of Concern (AOCs) for this study. These AOCs are described in detail in Section 2.2.2. A random sampling grid was established to characterize the areas not contained within the AOCs. ICF Kaiser then chose analytical parameters based on previous information and the ICM and Site histories. Soil samples were collected and analyzed for these parameters to adequately assess the Site soil quality. The analytical data was screened under Act 2 guidelines and potential human health effects were evaluated.

2.2.1 <u>Summary of Historical Information</u>

Duncan, Lagnese and Associates, Inc. (DLA) performed an environmental assessment of the National and Duquesne plants, publishing the results of this study in a May 1988 report. The conclusions of this report indicated two major contaminated soil locations at the National plant - the seamless mill oil tanks (west of the Site) and near the roundhouse (east of the Site, adjacent to the Walker Thickener Area).

The 1988 report also provided a detailed Site inventory, highlighting locations of materials such as asbestos and PCB-contaminated electrical equipment across the Site and throughout the ICM. As discussed in Section 1.4, these environmental hazards were remediated prior to this investigation of the Site.

Soil samples collected in the Site area did not indicate the presence of analytes at concentrations in excess of the Media-specific Concentrations (MSCs) published by PADEP.

2.2.2 Sampling in Areas of Concern

The following AOCs were identified by ICF Kaiser as areas with potential soil contamination issues as a result of former operations or by visual identification of stained soils. These AOCs served as the focal points for a portion of the field survey. The locations of the soil samples collected from these AOCs are shown in Figure 2-1.

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Although ICF Kaiser has been able to determine the types of potentially released materials within individual AOCs based on knowledge of the steel making process, it was not possible to estimate the volume of potentially released materials. This study focused on the areas of concern which ICF Kaiser believes represent the areas of the Site with the highest detectable constituent concentrations.

2.2.2.1 Electric Repair Shop and Powerhouse (AOC-1)

This building housed electrical transformers and associated electrical equipment used to generate and transmit power to various areas of the plant. Due to the nature of this equipment, there is potential for polychlorinated biphenyls (PCBs) and PCB-contaminated materials in and around the structure. Because the area was used as a repair shop, it is possible that hydrocarbon solvents were used for degreasing purposes. Six soil samples were collected from areas where electrical equipment and work bays were located in the interior of the structures, as well as outside the north wall of the building where the transformers were located. These samples were analyzed for PCBs, poly-aromatic hydrocarbons (PAHs), and target analyte list (TAL) metals.

2.2.2.2 Pipe Storage Building (AOC-2)

This building was used to store drummed wastes and recycled materials generated during on-site remediation activities. The structure has since been demolished. Due to the wide range of wastes that were handled and stored in this structure, ten samples were collected from the former interior of the structure and analyzed for TAL metals, PCBs, and PAHs.

2.2.2.3 Walker Thickener Area (AOC-3)

The Thickener was used to treat various process waters from the plant. As part of the ICM's rehabilitation program, the Thickener was demolished. Duncan, Lagnese & Associates (1988) reported visual staining in this area. Six samples were collected in the area and analyzed for TAL metals, PAHs, and PCBs.

2.2.3 Random Sampling

Random samples were collected across the Site in areas outside of the AOCs using a statistical method for determining the number of samples. The locations of the samples were determined by using a random number generating method. The details of how the locations and quantity of samples were chosen are presented in the Phase II Work Plan (ICF Kaiser, 1996). The nine samples were analyzed for PAHs, PCBs, and TAL metals.

2.3 SITE INVESTIGATION METHODOLOGY

2.3.1 Soil Sample Collection

The methods for collecting the soil samples followed ICF Kaiser's corporate Standard Operating Procedures (SOP). The surface samples were collected from the 0 to 0.5 ft-bgs interval with the use of hand tools. The 0 to 0.5 ft-bgs interval was loosened with a shovel around the perimeter of the sample location. After this area was loosened, a disposable, dedicated scoop was used to retrieve soil from the center of the area loosened by the shovel but not contacted by the shovel. The scoop is designed to retrieve only the fraction of the soil that is smaller than gravel size.

2.3.2 Sample Handling and Documentation

Soil samples were stored in coolers at approximately 4 degrees Celsius immediately after sample collection. Strict sample numeration and chain-of-custody procedures were followed. Samples were submitted to a courier for delivery to Microbac Laboratories in Warrendale, Pennsylvania.

2.3.3 **Equipment Decontamination**

No decontamination of sampling equipment was required during surface soil collection. Disposable scoops were used to collect the finer fractions of soil from the undisturbed portion of the loosened soil. Scoops were not reused for sample collection.

2.3.4 Quality Assurance/Quality Control (QA/QC) Samples

QA/QC samples were collected to ensure that analytical results were representative of field conditions. A rinsate blank sample (Rinse Blank-001 and Rinse Blank-002, distilled water poured into a decontaminated stainless steel bowl) was collected to test the effectiveness of decontamination procedures. Duplicate samples (Random 1/Random 2, Random 23/Random 24, AOC2-SB01-0001/AOC2-SB01-0001 D, and RAN-SB08001/RAN-SB08001 D) were collected to test the consistency of laboratory procedures.

2.3.5 **Laboratory Analytical Methods**

The laboratory methods used for analysis of sample parameters are outlined below:

Polyaromatic Hydrocarbons	SW 846 Method 8270
Polychlorinated Biphenyls	SW 846 Method 8080
Metals (except arsenic	SW 846 Method 6010
mercury, selenium and silver	
Arsenic, mercury, selenium,	SW-846 7000 series
and silver	
Cyanide	SW-846 9010

3.0 RESULTS OF THE SOIL SAMPLING PROGRAM

3.1 SUMMARY OF FINDINGS

The results of the soil sampling effort show that the compounds presented in Table 3-1 exceed the Pennsylvania Land Recycling and Environmental Remediation Standards Act (Act 2) Media-specific Concentrations (MSCs) for soils at non-residential sites.

TABLE 3-1
Compounds Exceeding the PA Act 2 Media-Specific Concentrations

Compound	PA MSC Non-Residential Surface Soil	Range of Detected Concentrations
Naphthalene	0.5	0.44 - 0.68
Lead	1,000	41 - 4,280
Vanadium	160	7.65 - 166

All concentrations given in mg/kg

The distribution of these constituents across the site varies by compound. Lead is found across the Site in AOC-1, AOC-3 and the random samples at concentrations above the MSCs. Vanadium and naphthalene exceeded MSCs in one sample each at AOC-3 and AOC-2, respectively. Table 3-1 lists the chemicals detected above the MSCs for soils.

3.2 RESULTS BY AREA OF CONCERN

The results of the soil sampling effort at the Site are presented in this section by Area of Concern. Since the data within most areas does not show any interrelationship, the data cannot be contoured. The discussion will focus on data that exceeds the Pennsylvania Act 2 MSCs. The laboratory reports and chain of custodies are given in Appendix A. It should be noted that the slag encountered at the Site makes the surficial materials extremely hard compared to other sites not engineered with slag fill.

3.2.1 AOC-1 Electric Repair Shop and Powerhouse

Within AOC-1, soil sampling was performed at two locations at the Powerhouse and two locations at the Repair Shop. The lead concentrations of 1,690 mg/kg (AOC1-SB001) and 2,032 mg/kg (AOC1-SB002) were the only results which exceeded the MSC. All other constituents analyzed were below the criteria. The data for these samples are given in Table 3-2 and graphically represented in Figure 2-1.

Table 3-2 Ridc McKeesport, pa - soil analytical data Area of concern 1 (with comparison to pennsylvania act 2 criteria)

CHEMICALID	Nos-Kendental	Son to	100 t 20 t 20 t 30 t 30 t 30 t 30 t 30 t	500	2001	
Aluminum	M	NA	29.200	26.030	23 500	ACC1-85004
Antimony	1,100	NA	20.0	2.63	200	20 20
Arranic	53	ΑX	11.5	9,66	Z.	ž
Barium	200,000	λĀ	378	327	34	130
Beryllium	18	NA	1.78	1.72	2.4	22
Cadmium	1,400	NA	ន	8.8	7.04	38.8
Chromium	14,000	NA	78.8	2.2	43.1	43.5
Cobelt	170,000	NA	7.67	6.39	12.3	11.7
Copper	100,000	NA	658	302	328	151
Iron	850,000	NA	77,700	68,200	196,000	90,750
Lond	1,000	NA	1,690	2,032	455	šč
Magnetium	NA	NA	10,020	9,010	3,990	3.037
Manganese	130,000	NA	3,170	3.220	2430	2.050
Mercury	240	Ϋ́	0.58	03	0.74	22
Nickel	57,000	NA.	21.4	077		1
Potassium	AN.	NA	1 660	100.	51.	8
Selenium	14,000	4Z	27.7	1	3	706'1
Silver	14.000	ΑΝ	22.50	20.00	200	8 6
Sodium	AX	NA.	ž	444	E.	3 6
Thellium	82	NA.	200	200	100	7
Venadium	160	NA	17.5	1	3 6	3 5
Zinc	850.000	ΑM	2.00.0	, 660		
						Š.
Acenephthene	170,000	720	<3.30	<1.65	<0.33	\$6.33
Acenaphthylene	170,000	989	330	<1.65	0.464	0.678
Anthracene	190,000	7.000	<3.30	<1.65	<0.33	0.918
Benzo(a)anthraceme	110	81	<5.30	<1.65	0.881	1.27
Benzo(b)fluoranthene	110	130	<3.30	<1.65	1.86	4.92
Benzo(k)fluoranthene	1,100	9,900	<3.30	<1.65	0.632	19.0
Benzo(a)pyrane		46	<3.30	<1.65	1.25	2.32
Benzo(g,h,i)perylene	170,000	180	<3.30	<1.65	0.757	2.42
Chrysene	11,000	230	330	<1.65	1.05	1.8
Dibenzo(a.h)anthracene	11	41	€30	<1.65	<0.33	<0.33
Fluoranthene	110,000	2,800	<3.30	<1.65	1.24	2.52
Fluorene	110,000	780	8.30	<1.65	<0.33	<0.33
Indeno(1,2,3-cd)pyrens	110	170	8.3	<1.65	0.772	2.05
2-Methylnaphthalene	110,000	110	330	<1.65	<0.33	<0.33
Naphthalene	110,000	0.5	05.50	<1.65	<0.33	<0.33
Phenanthrene	190,000	28,000	<3.30	<1.65	0.632	1.35
Pyrane	85,000	2,400	65.50	<1.65	1.25	3.06
CB-1010	200	18	<0.05	<0.5	<0.05	<0.05
CB-1221	160	0.14	<0.05	<0.5	<0.05	<0.05
PCB-1232	160	0.52	<0.05	<0.5	<0.05	<0.05
PCB-1242	160	36	<0.05	<0.5	<0.05	<0.05
CB-1248	æ	18	<0.05	<0.5	<0.05	<0.05
PCB-1254	2	7.8	<0.05	<0.5	<0.05	<0.05
PCB-1260	130	300	0.104	1.88	700 0	101.0
					3	
					20.0	×.15%

All values given in mg/Kg (dry weight) unless otherwise specified.
Shaded values indicate concentrations above criteria.

NA. Not applicable

NML. No Numeric Limit

3.2.2 AOC-2 Pipe Storage Building

The surface samples taken from AOC-2 showed that naphthalene at AOC2-SB006 exceeded its Pennsylvania Act 2 MSC. All other constituents analyzed were below criteria. Table 3-3 and Figure 2-1 show the results of the laboratory analysis for AOC-2.

3.2.3 AOC-3 Walker Thickener Area

Constituents that exceeded their Pennsylvania Act 2 MSCs in AOC-3 include lead and vanadium. The analytical data for AOC-3 are presented in Table 3-4. Figure 2-1 shows the spatial distribution of constituents detected above criteria.

3.3 RESULTS OF RANDOM SOIL SAMPLES TAKEN OUTSIDE OF AOCS

The only constituent that exceeded its Pennsylvania Act 2 MSC in the random samples collected was lead at a concentration of 1,120 mg/kg at location RAN-SB001, which is adjacent to AOC-3. No other constituents were detected above the screening criteria. The analytical data for the random sampling is presented in Table 3-5 and Figure 2-1.

Table 3-3 Ridc McKeesport, pa - soil analytical data Area of Concen'z (With Comparison to Pennsylvania act 2 criteria)

Chamberton

	Pennsylvania Medium Soc	Specific Concentrations										
	Non-Residential											
CHEMICAL ID	Surface Sog	Groundwater	AOC2-SB001	AOC2-SB002	AOC2-SB003	AOC2-SB004	AOC2-SB005	AOC2-SB006	AOC 2. SB007	\$000 ED00	500	000
Aluminum	NA.	NA	8,280	8,400	31.000	20.250	·	18 040	10 600	ACCI-SBOOM	AUCZ-SB009	AOC2-SB010
Antimony	1,100	NA	<2.18	422	222	25.28	96.00	2 2	25.50	20,000	28,200	32,800
Argenic	53	NA	9	14.8	8,09	14.2	10.4	12.5	8 3		27.0	47.77
Berium	200,000	AA	81.7	85	222	320	ř			10.8	7.38	5.26
Beryllium	18	MA	===	-	2.57	27.6	1 2 2	5	86	X.	470	282
Cadmium	1,400	NA	6.75	*	123	3.30	80.5		7,12	1.74	3.72	4.61
Chromium	14,000	Ϋ́	34	27.5	836	27.6	3.30	3.37	3.78	5.42	4.72	3.6
Cobalt	170,000	ΑX	12.4	9.6			33.6	41.4	70.6	70.7	50.4	39.7
Copper	100.000	ΨZ		6,1	67.0	4.4	8.8	6.59	10.4	88.6	6.68	5.67
Iron	850 000	27.	7.86	280	82.3	1,200	102	117	181	261	134	91.3
[Jess	200,000	NA	\$07,000	108,090	116,000	71,500	128,000	29,900	90,070	187,000	95,050	86.400
Masnamirm	3,000	AA	92.5	152	4	127	273	. 172	267	13	81	91.8
The state of the s	A'A	NA	2,740	1,880	5,960	6,044	8,210	7,607	6,340	6.000	700 6	578
A THE PROPERTY OF THE PARTY OF	130,000	NA	1,880	22.6	1,370	1,880	5,310	2.850	2.580	2 170	0292	200
Mercury	2%0	NA	0.088	0.21	990.0	0.14	0.1	0.28	0.12	0.43	8.6	1 00
Michel	57,000	NA	10.4	16	8.46	13	19,3	14.2	14.9	0 74 0	13.5	0::
Potestium	NA	NA	383	614	1,170	895	1.210	81.	1 030	501	100	11.8
Selentum	14,000	NA	4.1	<1.38	<1.38	2.4	×1.38	12	2017		200	000
Silver	14,000	NA	<0.22	<0.22	<0.22	<0.23	22.0	70.00	100	1017	X 2	\$ 1V
Sodium	ΝA	NA	85	262	512	202	8	500	\$ 5	20.00	\$0.23	<0.22
Thallium	230	NA AN	<2.18	<2.22	110	8 5	8 6	Ŕ	638	218	910	1.010
Vanadium	160	NA AN	12.3	355	1776		87.7	87.7	22.36	<2.45	<2.25	22
Zinc	850,000	NA AA	266	202	326			10.4	16.5	81	9.48	20.3
					1	8	ess	337	402	1.065	395	ž
Acenaphthene	170,000	720	<0.33	<0.33	<0.33	\$6.33	11.0>	133	20,07	100		
Aconaphthylens	170,000	989	<0.33	<0.33	25.00	20.33	93		50.33	<0.33	<0.33	<0.33
Anthracene	190,000	7,000	<0.33	<0.33	<0.33	50 33	20.33	50.00	50.33	<0.33	<0.33	<0.33
Benzo(a)anthracene	110	81	<0.33	2.	<0.33	£ 0>	20 33	6	6.3	6.95	<0.33	<0.33
Benzo(b)fluoranthens	110	130	<0.33	231	0.602	20.33	5033	27.0	50.50	C0.33	<0.33	<0.33
Benzo(k)fluoranthene	1,100	006'6	<0.33	0.787	<0.33	<0.33	20 33	20.33	6.5	0.4/3	<0.33	<0.33
Benzo(a)pyrene	11	46	<0.33	1.5	0.448	<0,33	<0.33	202	5	600	20.33	<0.33
Benzo(g. h.i)perylene	170,000	180	<0.33	0.849	<0.33	<0.33	<0.33	200	5 5	5.50	50.33	<0.33
Chrysene	11,000	230	<0.33	1.49	0.451	<0.33	0 33	850	5 6	3	50.33	<0.33
Dibenzo(a,h)anthracene	11	41	<0.33	<0.33	<0.33	<0.33	<0.33	\$633	50.00	6.5	50.50	50.33
Fluoranthene	110,000	2,800	<0.33	1.24	<0.33	<0.33	0.4	\$05.0	50 33	907.0	600	50.33
Fluorene	110,000	780	<0.33	<0.33	<0.33	<0.33	25.00	20 23	3 5	2000	200	50.55
Indeno(1,2,3-cd)pyrane	110	170	<0.33	0.944	<0.33	<0.33	25.00	3 5	600	50.33	<0.33	<0.33
2-Methylnaphthalene	110,000	110	<0.33	<0.33	<0.33	20.33	200	936.0	5 5	50.33	<0.33	<0.33
Naphthalene	110,000	0.5	<0.33	<0.33	<0.33	50.33	20.33	602.0	50.00	50.05	<0.33	<0.33
Phenauhrens	190,000	28,000	<0.33	9990	0.374	0.435	150	200.0	500	56.W	<0.33	<0.33
Pyrene	85,000	2,400	<0.33	1.43	0.371	15.05	20.33	0.037	500	0.401	0.451	<0.33
						+		†	S S S S S S S S S S S S S S S S S S S	0.481	0.441	<0.33
PCB-1016	200	18	<0.05	<0.05	<0.05	<0.05	\$0.05	50.05	30.00	30.07		
PCB-1221	160	0.14	<0.05	<0.05	<0.05	<0.05	20.05	20.65	50.07	60.0	20.03	<0.05
PCB-1232	160	0.52	<0.05	<0.05	<0.05	<0.05	<0.05	\$0.05	20.02	800	60.07	50.05
PCB-1242	160	16	<0.05	<0.05	<0.05	<0.05	0.233	0.080	20.05	20.07	20.03	\$0.03
PCB-1248	\$	18	<0.05	<0.05	<0.05	<0.05	<0.05	\$0.05	20 65	100	60.02	60.05
PCB-1254	\$	7.5	<0.05	<0.05	<0.05	<0.05	<0.05	\$0.05	20.05	80.0	60.07	\$0.05
PCB-1260	ž	200	<0.05	<0.05	<0.05	<0.05	<0.05	90.0	<0.05	6,069	50.05	20.05
100 - 114 - 100 V												200
1 Oct BOLDE (%)			91.7	90.2	90.4	87.4	88.5	84.8	84.6	81.5	88.9	8

All values given in mg/kg (dry weight) unions otherwise specified.
Shaded values indicate concentrations above criteria.
NA: Not applicable
NMI. No Aumeric Limit

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Table 3-4 Rudc McKeesport, pa - soil analytical data Area of Concern 3 (with comparison to pennsylvania act 2 criteria)

Limsters

(Characteristics)

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	rennsywania Medium	Pennsylvania Medium Specific Concentrations						
	Non-Residential	Soli to	7					
Chemical ID	Surface Soil	Groundwater	AOC3-SB001	AOC3-8B002	AOC3-SB003	AOC3-SB004	AOC3-8B-005	AOC3-SB006
Aruminum	NA.	NA	8,068	12,700	21,600	24,080		29,900
Antimony	1,100	NA	<2.33	30.8	<2.31	42.36	427	8.0
Arvenic	53	NA	35.1	33	14.6	15	20.3	12.8
Barium	200,000	NA	121	166	188	477	212	102
Beryllium	13	NA	0.79	1.04	1.87	2.26	871	2.41
Cadmium	1,400	NA	6.97	7.57	5.17	7.62	7.38	\$2
Chromitum	14,000	NA	89.3	55.5	89	88.1	69.5	46.1
Cobatt	170,000	NA	12.6	11	9.08	1.01	1 01	2.11
Copper	100,000	NA.	155	263	81.8	125	193	417
Iron	850,000	NA	260,000	166,000	146,000	183.000	230,200	135,000
Lond	1,000	AN AN	8	4.280	\$20	1 054	y S	27.00
Magnesium	NA	ΑN	1.750	3.040	000 9	0103		0,470
Manganess	130,000	ΑΝ	3.620	4.360	17.800	0,210	33,	0,5,0 0,0
Mercury	240	AN	0.56	0.42	0.30	233	001	X8/2
Nickel	97,000	NA	39.9	20.4	191	3	10.5	F.T.
Potanium	ΝA	ΑN	\$60	802	1 220	1 430	200	81
Solonium	14,000	ΑΝ	<1.38	<13	77	21.43	915	6,200
Silver	14,000	NA	<0.23	<0.23	<0.23	77.0>	20.05	75.00
Sodium	NA	NA	171	29.7	455	486	82	3.12
Thallium	230	NA	<2.33	2,23	<2.31	238	222	87.7
Venadium	160	NA	19.7	13.8	991	21	26.5	13.2
Zinc	850,000	NA	836	3,606	764	2,028	191	130
								244
Acenephthene	170,000	027	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33
Cenaphthylene	170,000	650	3.02	0.891	<0.33	<0.33	<0.33	633
University	190.000	7,000	2.75	0.995	<0.33	<0.33	<0.33	<0.33
Senzo(a) anunaceme	110	18	7.04	1.89	<0.33	<0.33	0.526	<0.33
Senzo Dinocambeno	110	130	20.5	3.39	0.704	0.615	0.812	<0.33
Senzo(a) inorminento	.100	9.900	5.79	3.12	<0.33	<0.33	<0.33	<0.33
many (a la la many	11	46	61.6	2.96	<0.33	<0.33	0.481	0.725
Chrysens	1,000	180		1.88	<0.33	<0.33	<0.33	9,564
Dibenzo(a h tenthracene	11,000	430	1.8	2.3	0.407	<0.33	0.581	<0.33
Fluoranthene	110 000	0000	77.0	20.05	50.33	<0.33	<0.33	<0.33
Fluorene	110 000	780	W. 5	7,77	<0.33	0.447	0.912	<0.33
Indeno(1.2.3-cd)pyrana	110	170		56.95	<0.33	<0.33	<0.33	<0.33
2-Methyinaphthalene	110.000	110	20.33	200	50.50	<0.33	<0.33	Q 33
Naphthalene	110,000	0.5	12.00	20.33	25.00	56.35	50.33	60.33
Phenanthrane	190,000	28,000	0.502	2	20.33	200		57 5
yrane	85,000	2,400	5.72	6	200	0.440	0 967	26.85
						À	(6)	6.3
PCB-1016	200	18	<0.05	<0.05	<0.33	<0.05	<0.05	<0.05
PG#1221	160	0.14	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
PCB-1232	160	0.52	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
PCB-1242	160	16	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
7B-1248	25	18	<0.05	<0.03	<0.05	<0.05	<0.05	<0.05
CB-1254	\$	75	<0.05	<0.05	0.117	0.25	0.267	<0.05
CB-1260	130	200	<0.05	<0.05	<0.05	<0.05	<0.05	0.071
Potel exlide								
			85.9	85.6	86.5	84.9	88.3	6:53

All values given in mg/Kg (dry weight) unless otherwise specified.
Shaded values indicate concentrations above criteria.
NA: Not applicable
NNL: No vumeric Limit

Table 3-5 RIDC MCKEESPORT, PA - SOIL ANALYTICAL DATA RANDOM SOIL SAMPLES (WITH COMPARISON TO PENNSTLVANIA ACT 2 CRITERIA)

CHEMICAL ID Aluminum Authony Arabic Barium Berylium	Non-Residential Surface Soil	tesklenting Soll to nee Soll Groundwater	RAN-58001	RAN-8B002	RAN-SB003	\$ 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8	RAN SBOOK	RAN-5B006	RAN-SB007	90000	900 B M 4 G
CHEMICAL ID Abunium Antimony Arenic Bartum Berjum	Surface Soil	Groundwater	RAN-88001	RAN-8B002	RAN-SB003	DAN CBOOL	PAN-SHOOF	RAN-SB006	RAN-SB007	2 4 5	0000 W 00000
Aluminum Animony Arenic Berium Berjuium			30, 4.	200	2000			- KAN-SB006	RAN-SB007	3 4 27 4 50 000	DAN CDANG
Anumony Arenic Berium Berylium	ZZ.	NA	10,050	45,000	14.400	15 300	16 100			KAIN-SEGOR	20000
Artenic Berium Beryllium	1,100	NA	<2.46	<2.24	72.00	2000	13,100	18,600	39,500	35,800	45,300
Berjum Beryllium	53	NA	81	10.2	18			X.V	249	22.56	<2.56
Beryllium	200,000	AX.	162	100	: ::	2	3.11	8.7	89	3.09	\$. \$.
	18	NA	1.78	4.24	308	910	col :	211	477	653	282
Cadmium	1,400	AN	13.8	5.89	2 80	3.25	1.36	2.03	3.49	3.58	4.58
Chromium	14,000	NA AA	136	93.8	805	3	50.3	271	4.04	2.%	2.67
Cobalt	170,000	NA	33.3	18.8	2:1		***		132	57.4	19.5
Copper	100,000	NA	335	160	23.1	***	10.5	8.78	13.6	9.46	4.17
Iron	350,000	ΑΝ	330,500	100.000	82 400	20.00	3/.1	212	118	85.8	3,360
Cond	1,000	¥	1 120	809		30,200	43,700	96,300	141,000	69,400	25,900
Magnetium	AN	NA	501.7	300	8	216	75.5	146	253	51.4	41
Manganese	130.000	₹X	COL.	10,000	7,770	6,490	4,470	5,900	8,350	10,500	10,530
Mercury	240	AX	90,400	0,730	2,130	1,450	8.	2,530	7,350	13,400	6,930
Nickel	57,000	AN.	366		0.22	0.13	0.25	0.32	<0.062	<0.064	<0.064
Potentium	AZ AZ	₹N	200	â	37.6	8.75	15.3	16.5	47.3	16.3	5.29
Selenium	14.000	NA		1,310	8	1.120	1.880	1,430	354	1,280	1,260
Silver	14,000	47		15/31	<132	√1.30	<1.38	¥.!∧	<1.46	<1.63	¥ ∨
Sodium	NA NA	V.		50.22	<0.22	×0.22	20.22	<0.23	<0.25	<0.26	\$0.26
Thellium	230	NA.	,,,	187	491	460	320	516	713	792	82
Vanadium	160	AV		7.77	22	42.20	423	7 7 7	2.49	2.8	42.56
Zinc	850,000	AV.	200	19.2	16.1	12.2	24.9	23.7	10.8	12.6	11.4
				8,	32%	865	383	ñ	230	71	1,580
Acenaphthene	170,000	720	<0.33	<0.33	56.05	1	25.05				
Acenaphthylene	170,000	959	1.58	<0.33	20 33	3 5	50.33	<0.33	<0.33	<0.33	<0.33
Anthracens	190,000	7,000	2.85	<0.33	0.411	20.33	50.33	0.619	<0.33	<0.33	<0.33
Benzo(a)anthracene	110	81	9.21	0.583	0.675	20 33	600	arc'h	<0.33	<0.33	<0.33
Benzo(b)fluoranthene	110	130	15.8	1.07	1.46	\$633	4.78	100	6.33	<0.33	<0.33
Benzo(K)Iluoranthene	1,100	9,900	4.16	0.392	0.666	<0.33	1	3.00	50.33	<0.33	<0.33
Denzo(a)pyrene	=	46	9.07	0.683	0.694	<0.33	10 G	***	65.05	20.33	<0.33
penzo(g.n.1)peryiene	170,000	180	5.85	0.488	0.433	<0.33	891	2033	666	<0.33	<0.33
City yaerie	11,000	230	10.2	0.692	0.978	<0.33	1.69	175	20 33	50.33	\$6.33
Flictonithese		41	0.483	<0.33	<0.33	<0.33	<0.33	<0.33	11.00	2 2	5 5
Fluorene	110,000	2,800		0.833	1.77	<0.33	4.81	4.18	<0.33	2033	200
Indeno(1.2.3-cd)nymne	110	780	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	60.33	F 6
2-Methymaphthalene	110 000	170	6.62	0.429	0.487	<0.33	1.51	<0.33	<0.33	<0.33	<0.33
Naphthalene	110,000	013	<0.33	<0.33	0.733	<0.33	<0.33	<0.33	<0.33	<0.33	60.33
Phenanthrene	190,000	0.3	<0.33	<0.33	0.439	<0.33	0.481	<0.33	<0.33	<0.33	<0.33
Pyrame	25 000	2,000	1.69	0.495	1.97	0.373	ï	1.03	<0.33	<0.33	69.33
	A00'00	4400	12.2	0.803	1.11	<0.33	3.2	3.58	<0.33	<0.33	<0.33
PCB-1016	200	81									
PCB-1221	160	71.0	20.03	<0.03	<0.05	<0.05	3.45	<0.05	<0.05	<0.05	<0.05
PCB-1232	160	0.59	<0.05	<0.05	<0.05	<0.05	<0.5	<0.05	<0.05	<0.05	<0.05
PCB-1242	160	31	20.03	<0.05	<0.05	<0.05	<0.5	<0.05	<0.05	<0.05	<0.05
PCB-1248	4	2 2	<0.03	<0.05	<0.05	<0.05	<0.5	<0.05	<0.05	<0.05	\$0.05
PCB-1254	3	16	<0.03	<0.05	<0.05	<0.05	<0.5	<0.05	<0.05	<0.05	<0.05
PCB-1260	130	905	2000	<0.03	<0.05	<0.05	<0.5	<0.05	<0.03	<0.05	<0.05
			CA:05	0.103	<0.03	0.13	<0.5	0.188	<0.05	<0.05	<0.05
Total solids (%)			81.4	89.1	7 98		+	1			

All values given in myKg (dry weight) unless otherwise specified.
Shaded values indicate concentrations above criteria.
NA: Not applicable
NNG: No turneric Limit

4.0 BASELINE RISK ASSESSMENT

Although not required under the Special Industrial Areas scenario, this risk assessment was prepared in a pro-active manner to help further delineate the potential impact that chemicals of concern may have on human health at the Site on the Industrial Center of McKeesport property. This Baseline Risk Assessment has been prepared in accordance with Pennsylvania's Land Recycling and Environmental Remediation Standards Act (Act 2). It represents a conservative assessment of potential health and environmental risks associated with conditions at the Site under current and planned future use in the absence of further measures to remediate or control the Site. This risk assessment was prepared in accordance with the Site-Specific Standard because it is considered to be the most appropriate for the Site because of the industrialized nature of the property and surrounding area. The Background Standard is inappropriate because the surrounding area is expected to be above background levels. The Statewide Health Standard is not applicable because concentrations of a few constituents detected at the Site exceed MSCs for non-residential sites.

In accordance with the Act 2 Technical Guidance (PADEP, 1995), this baseline risk assessment consists of both a human health risk assessment (HHRA) and an ecological risk assessment (ERA). However, because the entire site is industrialized, there are no ecological habitats on the property, and thus no potential for adverse ecological effects. Adjacent properties are similarly industrialized or urbanized, with no potential for ecological effects. The Site does border the Monongahela River, a potential ecological habitat. However, the only mechanism for the site to affect the river is through groundwater discharge. This is a heavily industrialized river; the relative impact of groundwater discharge from the site to the river is negligible compared to other sources. In addition, as was discussed in the *Groundwater Quality Assessment Summary Report* (ICF Kaiser, 1993), Site groundwater is not likely to contribute detectable levels of constituents to the river due to low concentrations present in groundwater and the high degree of dilution in the river. Based on this assessment, further evaluation of ecological effects associated with the Site is not necessary.

The focus of this risk assessment is on constituent levels detected in Site soils. Although constituents have been detected in groundwater beneath the Site, this medium was previously evaluated and shown not to pose significant risks to human health (ICF Kaiser, 1993). Wells are not permitted on-site and new tenants are required to hook into the McKeesport Water System so groundwater will not be used as a source of drinking water. Therefore, further evaluation of groundwater pathways for human receptors is not necessary.

4.1 GENERAL APPROACH

As specified in PA DEP Technical Guidance (PADEP, 1995), the HHRA was conducted in accordance with the most recent USEPA (1989, 1991, 1992) and USEPA Region III risk assessment guidance (USEPA Region III, 1993, 1995). The approach to the HHRA is consistent with the above cited guidance and includes the following four steps:

- Identification of Constituents of Interest (also known as Hazard Identification). An evaluation of site investigation data and identification of constituents of interest with regard to potential health effects;
- Exposure Assessment. Identification of the receptors likely to be exposed to site-related constituents and the likely extent of their exposure under defined exposure scenarios;

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- Toxicity Assessment. A description of the relationship between the magnitude of exposure (dose) and the probability of occurrence of adverse health effects (response) associated with the constituents of interest; and
- Risk Characterization. Description of the nature and magnitude of potential health risks, and a discussion of uncertainties in the analysis.

4.2 IDENTIFICATION OF CONSTITUENTS OF INTEREST

The purpose of this section of the HHRA is to identify the constituents found at the Site that will be evaluated quantitatively in the risk assessment. This section will present the analytical data for the Site that were used to identify constituents present at or released from the Site. Then, applying standard selection criteria, constituents of interest are identified for detailed quantitative evaluation. Constituents of interest are generally defined as those constituents present at a site that are most likely to be of concern to human health.

Data on constituent levels in soil associated with the Site were discussed in Section 3.0. A summary of the data, including the frequency of detection and range of detected concentrations is presented in Table 4-1.

These data were reviewed and evaluated to identify the constituents that require further evaluation in the risk assessment. This selection process was performed by comparing the maximum detected concentration of each constituent to appropriate risk-based screening criteria, in accordance with USEPA Region III guidance (1993). The first set of screening criteria used consisted of the PA DEP MSCs for soil at non-residential sites (PA DEP, 1995). This screening is also presented in Table 4-1.

As indicated, most of the detected constituents are well below PA DEP and/or USEPA screening criteria, and thus may be eliminated from further evaluation in the risk assessment. This elimination process does not mean that the eliminated constituents do not contribute to the total potential risk at the Site, only that their contribution is insignificant relative to those constituents present above their respective criteria. This process allows the risk assessment to focus on those constituents with a reasonable probability of being associated with a potential risk.

Only three constituents were detected above their respective MSCs: naphthalene, lead and vanadium. Of these, only lead requires further evaluation in the risk assessment for the following reasons.

Naphthalene was only detected in one sample (AOC2-SB06000) above its MSC of 0.5 mg/kg. This MSC is developed for protecting groundwater quality beneath soils containing naphthalene. The mean and 95% upper confidence limit of the mean concentrations of naphthalene were 0.28 and 0.32 mg/kg (calculations in Appendix B), both of which are below the MSC. In order for constituents in soil to adversely impact groundwater quality, there must be a considerable mass within the vadose zone. These data indicate that a source of naphthalene is not present. Groundwater monitoring conducted at the site in 1993 did not identify naphthalene in any samples. Consequently, it is reasonable to conclude that naphthalene in soil does not represent a hazard to groundwater and further evaluation in the risk assessment is not required.

For the two remaining constituents, lead and vanadium, different risk assessment approaches must be used. For lead this is true because there are no quantitative toxicity criteria (cancer slope factors and reference doses) to assess potential risks associated with lead exposure. As discussed in Section

TABLE 4-1 PRELIMINARY SCREENING FOR CONSTITUENTS OF INTEREST

h

	Frequency	Range of	Range of	Pennsylvania		Constitutions	D-411-
	Jo	Detected	Detection	Medium Specific Concentrations	centrations	Jo	oregion and a second
Constituent	Detection	Concentrations	Limits	Industrial	Soil to GW	00000000	m County A
ORGANICS							
2-Methylnaphthalene	2/31	0.73 - 0.76	0.33 - 3.3	110,000	110	CN	Maximim less than MSC
Acenaphthylene	6/31	0.46 - 3.02	0.33 - 3.3	170,000	650	ON	Maximum less than MSC
Anthracene	6/31	0.41 - 2.85	0.33 - 3.3	190,000	7,000	NO	Maximum less than MSC
Benzo(a)anthracene	11/31	0.53 - 9.21	0.33 - 3.3	110	89	2	Maximum less than MSC.
Denzo(a)pyrene	13/31	0.45 - 9.19	0.33 - 3.3	dong Emil	46	SN ON	Maximum less than MSC.
Denzo Dinoranhene	16/31	0.47 - 20.5	0.33 - 3.3	110	130	NO	Maximum less than MSC.
Benzo(g,h,1)perylene	10/31	0.43 - 5.85	0.33 - 3.3	170,000	180	ON.	Maximum less than MSC
Benzo(k)fluoranthene	10/31	0.39 - 5.79	0.33 - 3.3	1,100	9,900	200	Maximum less than MSC
Chrysene	15/31	0.41 - 10.2	0.33 - 3.3	11,000	230	NO	Maximum less than MSC
Uibenzo(a,h)anthracene	2/31	0.42 - 0.48	0.33 - 3.3	bood Bood	41	ON	Maximum less than MSC
Fluoranthene	16/31	0.4 - 11	0.33 - 3.3	110,000	2,800	NO	Maximum less than MSC
Indeno(1,2,3-cd)pyrene	9/31	0.43 - 6.62	0.33 - 3.3	011	170	NO	Maximum less than MSC
Naphthalene	3/31	0.44 - 0.68	0.33 - 3.3	110,000	0.5	YES	
PCB-1016	1/31	3.45	0.05 - 0.5	200	18	SN ON	Maximum less than MSC
PCB-1242	3/31	0.07 - 0.23	0.05 - 0.5	160	16	CX	Maximim less than MCC
PCB-1254	4/31	0.11 - 0.27	0.05-0.5	44	75	ON	Maximim less than MSC
PCB-1260	11/31	0.06 - 1.88	0.05 - 0.5	130	500	CX	Maximum less than MSC
Phenanthrene	18/31	0.37 - 1.97	0.33 - 3.3	190,000	28,000	ON	Maximim less than MSC
Pyrene	16/31	0.37 - 12.2	0.33 - 3.3	85.000	2.400	CZ	Movimum less than Man
INORGANICS						200	Markingh 1988 than 1930.
Aluminum	31/31	8,068 - 45,300	-	NAT.	NA	CX	Maximum Lear oban MSC
Antimony	1/31	30.8	2.18 - 2.56	1,100	NA	CX	Maximum less than MCC
Arsenio	29/31	3.09 - 35.1	1.34 - 1.43	53	ŊĄ	S	Maximim less than MSC
Barium	31/31	81.7 - 736	1	200,000	NA	ON.	Maximum less than MSC
Beryllium	31/31	0.79 - 4.61	1	18	NA	NO	Maximum less than MSC.
Cadmium	31/31	2.05 - 38.8	•	1,400	NA	ON	Maximum less than MSC.
Chromium*	31/31	19.5 - 136	ì	14,000	NA	NO ON	Maximum less than MSC.
Cobait	31/31	1.01 - 33.3	1	170,000	NA	NO	Maximum less than MSC.
Copper	31/31	37.1 - 3,860	1	100,000	NA	ON	Maximum less than MSC.
Tron	31/31	25,900 - 407,000	1	850,000	NA	ON	Maximum less than MSC.
Lead	31/31	41 - 4,280	1	1,000	NA	YES	
Magnesium	31/31	1,750 - 10,630	ı	NA	NA	ON.	Low inherent toxicity.
Manganese	31/31	927 - 17,800	1	130,000	NA	NO	Maximum less than MSC.
Mercury	27/31	0.07 - 35.6	90.0	240	NA	SN SN	Maximum less than MSC
Nickel	31/31	5.29 - 82.5	ı	57,000	NA	2	Maximum less than MSC
Fotassium	31/31	354 - 2,505	ł	NA	NA	NO.	Low inherent toxicity.
Sodium	31/31	177-3,170	ı	NA	NA	SN SN	Low inherent toxicity
Vanadium	31/31	7.65 - 166	1	160	NA	YES	
Zino	31/31	62.6 - 3,606	1	850,000	NA	NO NO	Maximum less than MSC.

All concentrations and criteria given in mg/Kg.

Criteria presented are for hexavalent chromium.
NA: Not applicable
NNL: No Numeric Limit

4.4, a separate model is used to evaluate lead. Thus, only vanadium can be evaluated using standard risk assessment methods. However, such an evaluation is not necessary because the concentration in soil that would be used to calculate risks is below the MSC for vanadium. EPA risk assessment guidance (1992) requires that the 95% UCL of the mean be used to represent the exposure concentration in calculating potential risks. The 95% UCL for vanadium is 24 mg/kg. This value is well below the MSC of 160 mg/kg, which in turn is based on an acceptable non-cancer hazard index of 1.0. If vanadium were to be carried through a quantitative assessment using the same assumptions as PA DEP used in calculating the MSC, the hazard index would be less than 1.0 (24/160 = 0.15). Therefore, further assessment of vanadium is not necessary and the remainder of the risk assessment addresses lead only.

4.3 EXPOSURE ASSESSMENT

Exposure assessment is the process of measuring or estimating the intensity, frequency, and duration of human exposure to an agent in the environment. This section of the HHRA discusses the mechanisms by which people might come in contact with constituents of interest and the estimated intensity, frequency, and duration of contact between potential human receptors and the constituents. The exposure assessment follows, as much as possible, the recommendations for conducting an exposure assessment provided by the USEPA (USEPA, 1989a).

An exposure assessment consists of three basic steps:

- 1) Characterization of the exposure setting.
- 2) Identification of exposure pathways.
- 3) Quantification of pathway-specific exposures.

These components are described in greater detail in the following subsections.

4.3.1 Characterization of the Exposure Setting

Potential exposure to constituents in the environment depends on a number of factors related to the physical characteristics of a site and its surroundings. These factors include location, surrounding land use, surface topography, drainage patterns, hydrogeology, meteorology, and vegetation. They also include factors related to the current and possible future site uses of the property, which determine the types of activities that might occur at the site, the degree to which the site is accessible to the general public, and the mechanisms that might result in migration of constituents to on-site and off-site populations.

The McKeesport site is currently occupied by one business. It is considered a "light" industrial manufacturing operation. There are also intermittent demolition and renovation activities occurring on-site. The planned future use of the McKeesport site is as an industrial park. Consequently, all exposure scenarios evaluated in this risk assessment are based on this industrial land use objective. Individuals with the opportunity to be on the property include workers on-site, occasional workers (e.g., delivery companies), construction workers, customers, and trespassers. Based on the above characterization, potential receptors to be considered on the site are the following:

- Adult workers employed at the site now and in the future,
- Occasional adult visitors to the site, and
- Occasional child trespassers.

The properties surrounding the site are industrial and/or urban as well. As was discussed in the Groundwater Quality Assessment Summary Report (ICF Kaiser, 1993), there are no opportunities for residents of the City of McKeesport or future inhabitants of the Site to be exposed to constituents in groundwater because the city receives its water from the Westmoreland County Public Water Supply and requires all new construction to connect to this supply for potable water. Use of groundwater for production purposes is unlikely because of the low recovery of the aquifer and the ready availability of river water. Thus, further evaluation of groundwater pathways is not necessary.

Based on this characterization, the potential off-site receptors are the following:

- Adult workers in adjacent properties,
- Adult and child residents west of the site, and
- Adults and children walking past the site.

4.3.2 <u>Identification of Exposure Pathways</u>

This section describes the potential pathways by which the above receptors could be exposed to constituents located at or released from the surface impoundment. An exposure pathway is a description of the mechanism by which an individual may come into contact with hazardous constituents in the environment. In accordance with USEPA Risk Assessment Guidance for Superfund (RAGS) (USEPA, 1989), all potential exposure pathways have been identified and evaluated. An exposure pathway is defined by four elements (USEPA, 1989):

- A source and mechanism of constituent release to the environment;
- An environmental receiving or transport medium (e.g., air, soil) for the released constituent;
- A point of potential contact with the medium of concern; and
- An exposure route (e.g., ingestion) at the contact point.

An exposure pathway is considered "complete" if all four elements are present.

Given the nature of the only constituent of interest — lead — potential exposure pathways are limited to those associated with direct contact with soil or entrainment of soil into the air as dusts. Thus, the following exposure pathways are relevant to the Site:

- 1. Adult industrial worker exposed to (a) surface soil via incidental ingestion and dermal contact; and (b) ambient air via inhalation of fugitive dusts.
- 2. Adult construction worker exposed to (a) surface and subsurface soil via incidental ingestion and dermal contact; and (b) ambient air via inhalation of fugitive dusts.
- 3. Older child/teenage trespasser exposed to (a) surface soil via incidental ingestion and dermal contact; and (b) ambient air via inhalation of fugitive dusts.

Other on-site receptors, such as occasional visitors to the site, need not be evaluated quantitatively because (1) their exposure pathways would be the same as those evaluated for the industrial worker,

and (2) they would be exposed much less frequently than the industrial worker. Thus, the industrial worker receptor represents a more conservative scenario.

Although, as discussed above, it is possible for off-site populations to be exposed to constituents in air as a result of fugitive dust emissions, this potential pathway will not be evaluated quantitatively because (1) the potential for such a release is minute due to the likely surface cover; and (2) off-site populations would inhale much lower concentrations of constituents than on-site populations. The evaluation of the inhalation pathway for the on-site receptors constitutes a sufficiently conservative evaluation of this pathway.

As will be discussed in Section 4.4, the EPA model used to evaluate potential risks associated with exposure to lead in soil at industrial sites is based on protecting the unborn fetus of a pregnant individual potentially present on the site. Fetuses, infants and small children are the most sensitive to the neurotoxic effects of lead exposure. EPA does have a model for evaluating potential risks to small children from lead in soil. However, this model is for residential scenarios only. Therefore, the only receptor evaluated quantitatively in this risk assessment is the fetus of a female worker at the site sometime in the future.

The EPA model is used to calculate an acceptable concentration in soil to be used as a benchmark against which site data are compared. As indicated in Table 4-1, the maximum detected lead concentration is 4,280 mg/kg. The mean and 95% UCL concentrations (see Appendix B for calculations) are 653 and 1,164 mg/kg, respectively. These site-specific values will be used to assess the potential for adverse effects associated with lead in soil.

4.4 TOXICITY ASSESSMENT FOR LEAD

Toxicity assessment is the process of characterizing the relationship between the dose of a constituent and the anticipated incidence of an adverse health effect. The majority of existing knowledge about the dose-response relationship for the constituents detected at the surface impoundment is based on data collected from studies of animals (usually rodents), studies of human occupational exposures, and theories about how humans respond to environmental doses of constituents. The USEPA has developed dose-response assessment techniques to assess risks associated with constituents in the environment and set "acceptable" levels of human exposure. These USEPA-derived toxicity criteria address both subchronic and chronic noncarcinogenic health effects, and potential carcinogenic health risks.

The USEPA has not derived reference doses (RfDs) for lead or lead compounds. The Agency's RfD Work Group decided against developing an inorganic lead RfD because a number of lead-induced health effects may occur at relatively low blood lead levels. Furthermore, they feel that the degree of uncertainty about lead's health effects is quite low in comparison to most other environmental toxicants. Few chemicals have been so well-characterized through extensive medical observation and scientific research. Thus, it is unlikely that USEPA will derive a RfD for lead in the future.

For residential CERCLA and RCRA sites, USEPA recommends using the Integrated Exposure Uptake/Biokinetic (IEUBK) Model (1994) to assess lead exposure. The IEUBK model predicts concentrations of lead in the blood of children based on the integrated exposure to lead from multiple sources, including soil and dust (such as might be associated with a site), water, air, food and paint. USEPA has used this model to derive a screening level of 400 mg/kg lead for residential sites. This concentration of lead is associated with an acceptable blood lead level in the majority (95%) of

children exposed to soil. Thus, concentrations less than 400 mg/kg entered into the model, with all other parameters set at the default assumptions, will indicate acceptable blood lead levels as well.

The USEPA's IEUBK model is appropriate only for chronic lead exposure to young children. Because of the industrial nature of this site, children are not likely to be frequently exposed to surface soil. Derivation of acceptable concentrations of lead in soil for adult workers has been an unresolved issue for many years. In order to resolve this issue for industrial sites, USEPA Region VI (1995) has developed draft guidance for calculation of an acceptable lead level in soils for the most sensitive adult receptor, a pregnant woman. This assessment incorporates that approach, as follows.

The blood lead level of the fetus in a hypothetically exposed female worker is the critical parameter in the equation for calculating an acceptable soil lead level. The target blood lead level for the fetus is 10 micrograms per deciliter (μ g/dl) for no more than 5% of an exposed population. The fetal blood lead level is related to the maternal blood lead level by an estimated relational value (R value) of 0.9. The acceptable soil lead concentration needed to meet these criteria is back-calculated by correlating the target maternal blood lead level (as it relates to the fetal blood lead level) to the exposure to lead in soil by a biokinetic slope factor. Exposure to lead is evaluated for incidental ingestion of both soil and dust. The equation and default input values used to calculate acceptable soil lead levels are as follows:

$$CS_{lead} = \frac{PbB_{GM}target - PbBo}{BKSF \times IRs \times EFs \times AFs \times Ksd \times IRd \times EFd \times AFd}$$

Symbol	Parameter	Value
CS _{lead}	Concentration of lead in soil (mg/kg)	Calculated
PbB _{GM} target	PbB _{95th} maternal / GSDi ^{1.645} where GSDi = 1.8	Calculated
PbB _{95th} maternal	$PbB_{95th} fetal / R$ where R = 0.9	Calculated
PbB _{95th} fetal	95th percentile blood lead in fetus	10 μg/dl
PbBo	Baseline blood lead level (average blood lead level of African American, Hispanic, and white women, ages 20-49)	1.9 μg/dl
BKSF	Biokinetic slope factor	0.4 μg/dl per μg/day
IRs	Ingestion rate soil	0.025 g/day
IRd	Ingestion rate dust	0.025 g/day
Ksd	[dust] / [soil]	0.7 (unitless)
EFs	Soil exposure frequency	250 days/year
EFs	Dust exposure frequency	250 days/year
AFs	Absolute absorption fraction of lead in soil	0.1 (unitless)
AFd	Absolute absorption fraction of lead in dust	0.1 (unitless)

The resulting soil lead concentration that yields an acceptable blood lead level for a pregnant woman is 2,000 mg/kg. This benchmark will be used to evaluate lead at this site.

EPA Region VIII has also developed a risk-based concentration for lead in soil using a similar type of model based on the fetus of a female worker at an industrial site (EPA Region VIII, 1995). Based

on this model, a target concentration of 11,100 mg/kg was developed. This value will also be used as a benchmark for comparison purposes.

4.5 RISK CHARACTERIZATION

Risk characterization is defined as the description of the nature and magnitude of potential human health risk, including attendant uncertainty. Risk characterization integrates the results of the Exposure Assessment and the Toxicity Assessment to estimate theoretical excess lifetime cancer risks and non-carcinogenic health effects associated with exposure to constituents. Typically, this integration provides quantitative estimates of either cancer risk or non-cancer hazard indices (HIs), which are compared to standards of acceptable risk.

As discussed in Section 4.2, the only constituent of interest with available toxicity criteria is vanadium, which has a reference dose. PA DEP used this reference dose to derive its MSC of 160 mg/kg, which is based on non-cancer effects. Because the exposure situation at the Site is similar to that assumed by PA DEP in deriving their MSCs, it is appropriate to directly compare the site-specific 95% UCL concentration of 24 mg/kg with the MSC of 160 mg/kg. The resulting ratio is analogous to hazard index. Since the ratio (0.15) is less than 1.0, adverse non-cancer effects are not expected.

Due to the lack of toxicity criteria for lead, similar calculations cannot be derived for lead. Rather, site-specific concentration estimates are compared with EPA benchmark criteria for protecting the fetus of a female worker. This comparison is summarized in Table 4-2.

TABLE 4-2
COMPARISON OF SITE-SPECIFIC LEAD CONCENTRATIONS
TO EPA BENCHMARK CRITERIA

Site	-specific Concentra	tions	EPA Industrial Be	enchmark Criteria
Maximum (mg/kg)	Mean (mg/kg)	95% UCL (mg/kg)	Region VI (mg/kg)	Region VIII (mg/kg)
4,280	653	1,164	2,000	11,100

From the comparison presented in Table 4-2 it is clear that the concentrations of lead in soil at the Site are well within acceptable levels established by the EPA for industrial sites. Both the mean and 95% UCL of the mean are below the Region VI and VIII benchmark, while even the maximum is below the Region VIII benchmark. Consequently, adverse health effects associated with lead in soil are not anticipated.

4.6 CONCLUSIONS

This baseline human health risk assessment has been prepared in support of the industrial redevelopment of the McKeesport site. This risk assessment was conducted in accordance with applicable PA DEP guidance under Act 2 (PA DEP, 1995), supplemented where appropriate by

USEPA risk assessment guidance (USEPA, 1989). Based on the planned industrial development of the property, the following exposure scenario was evaluated:

Pregnant Female Industrial Worker - exposure to surface soil via incidental ingestion and dermal contact; and inhalation of fugitive dusts.

All detected constituents except naphthalene, lead and vanadium were present below the PA DEP MSCs for soil at an industrial site. Naphthalene did not require further evaluation because the MSC is based on protecting groundwater and the concentrations of naphthalene in soil are too low to pose a threat to groundwater. In addition, groundwater data from the site indicate that naphthalene is not present (ICF Kaiser, 1993). Vanadium was also not evaluated quantitatively because the 95% UCL concentration of 24 mg/kg is well below the MSC of 160 mg/kg, indicating that potential non-cancer effects associated with vanadium are unlikely.

In the absence of appropriate criteria, lead was evaluated using the USEPA Region VI screening level of 2,000 mg/kg and Region VIII screening level of 11,100 mg/kg, both of which are based on pretesting the fetus of a female worker. The detected concentrations of lead in soil are within the EPA benchmark levels, indicating that adverse health effects from lead in soil are not likely.

REFERENCES

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Appendix B Field Notes



Test Trenching Activities 11.03.2014 East Portion of 307-D-1 – McKeesport

- Onsite at 8:10AM with Todd Washlaski (Geo Environmental)
- Unloaded backhoe at 8:20AM

Test Trench #4

- Started at southwest corner moving east
- Very hard surface could not dig through with millings from a roadway or old parking lot
- Next, hit building debris bricks
- Then, concrete pieces including larger slabs and small boulder sizes
- Also, ran into old pipes
- East side dug into concrete slab
- West to East
- 0 to 40 ft paved parking lot or roadway
- 40 to 75 ft down to 4 feet ok
- 75 ft 0.5 ft refusal (concrete)
- 76 to 120 ft down to 4 feet ok
- 120 to 135 ft 0.5 ft refusal (concrete)
- 135 to 167.5 ft concrete at 2.5 ft
- 167.5 to 172.5 ft down to 4 feet ok
- 172.5 to end concrete pad below surface
- PID of samples A and B fluctuated as background did 0.1 to 0.5
- Samples A-10AM and B-10:30AM

Test Trench #3

- West to East
- 0 to 27.5 ft refusal at 3-4 inches down
- 27.5 to 35 ft down to 4 feet ok
- 35 to 45 ft 0.5 feet down refusal
- 45 to 57.5 ft 1.5 ft refusal
- 57.5 to 65 ft down to 4 feet ok
- 65 to 67.5 ft 1 ft refusal
- 67.5 to 90 ft varying up and down 1.5 to 4 feet
- 90 to 102.5 ft 0.5 ft concrete slab
- 102.5 to 120 ft down to 4 feet ok
- 120 ft to end 1.5 to 2 feet in depth, then refusal
- PID for A and B equal to background
- Samples A-10:45 AM and B-11:00AM

Test Trench #1

- South to North
- 0 to 10 ft down to 4 ft with chunks of concrete and bricks
- 10 to 17.5 ft crosses Test Trench #4
- 17.5 to 65 ft 2 to 4 feet down with bricks and small concrete chunks

- 65 to 72.5 ft crosses Test Trench #3
- 72.5 to end 0.5 ft then refusal
- PID A and B equals background
- Samples A-11:15 AM and B-11:30AM

Test Trench #2

- North to South
- 0 to 10 ft 1.5 feet then refusal
- 10 to 17.5 ft crosses Test Trench #3
- 17.5 to 32.5 ft down to 4 feet ok
- 32.5 to 37.5 ft 0.5 feet refusal
- 37.5 to 52.5 ft 1 ft refusal
- 52.5 to 55 ft surface refusal
- 55 to 67.5 ft large pieces of concrete and bricks, but got to 4 feet down
- 67.5 to 75 ft crosses Test Trench #4
- 75 to 85 ft 2 ft depth refusal
- PID for A and B samples equals background
- Samples A-12:00PM and B-12:15PM

Appendix C Photographs





TEST TRENCH #4
WEST STARTING POINT



TEST TRENCH #4
WEST HALF

PHOTOGRAPHS DEPICT CONDITION OF THE SUBJECT PROPERTY AS OF NOVEMBER 03, 2014



PROPERTY PHOTOGRAPHS

EAST PORTION OF PARCEL 307-D-001 CENTER STREET PARCEL MCKEESPORT, PENNSYLVANIA

DRAWN BY:	SBU	11/04/14
CHECKED BY:	SBU	11/04/14
APPROVED BY:	SBU	11/04/14
DRAWING NO.	TCVC	14341CSP
PLATI	<u> </u>	



TEST TRENCH #4
CENTER PORTION



TEST TRENCH #4
CENTER PORTION

PHOTOGRAPHS DEPICT CONDITION OF THE SUBJECT PROPERTY AS OF NOVEMBER 03, 2014



PROPERTY PHOTOGRAPHS

EAST PORTION OF PARCEL 307-D-001 CENTER STREET PARCEL MCKEESPORT, PENNSYLVANIA

DRAWN BY:	SBU	11/04/14
CHECKED BY:	SBU	11/04/14
APPROVED BY:	SBU	11/04/14
DRAWING NO.	TCVC14341CSP	
PLATI	 E 2	



TEST TRENCH #4
CENTER PORTION



TEST TRENCH #4
CENTER PORTION

PHOTOGRAPHS DEPICT CONDITION OF THE SUBJECT PROPERTY AS OF NOVEMBER 03, 2014



PROPERTY PHOTOGRAPHS

EAST PORTION OF PARCEL 307-D-001 CENTER STREET PARCEL McKEESPORT, PENNSYLVANIA

DRAWN BY:	SBU	11/04/14
CHECKED BY:	SBU	11/04/14
APPROVED BY:	SBU	11/04/14
DRAWING NO.	TCVC14341CSP	
PLATI	E 3	



TEST TRENCH #4 LOOKING WEST FROM EAST END



TEST TRENCH #4
LOOKING EAST FROM
CENTER PORTION

PHOTOGRAPHS DEPICT CONDITION OF THE SUBJECT PROPERTY AS OF NOVEMBER 03, 2014



PROPERTY PHOTOGRAPHS

EAST PORTION OF PARCEL 307-D-001 CENTER STREET PARCEL McKEESPORT, PENNSYLVANIA

DRAWN BY:	SBU	11/04/14
CHECKED BY:	SBU	11/04/14
APPROVED BY:	SBU	11/04/14
DRAWING NO.	TCVC14341CSP	
PLATI	E 4	



TEST TRENCH #3
EAST STARTING POINT



TEST TRENCH #3 & 4 LOOKING EAST FROM WEST SIDE OF PARCEL

PHOTOGRAPHS DEPICT CONDITION OF THE SUBJECT PROPERTY AS OF NOVEMBER 03, 2014



PROPERTY PHOTOGRAPHS

EAST PORTION OF PARCEL 307-D-001 CENTER STREET PARCEL MCKEESPORT, PENNSYLVANIA

DRAWN BY:	SBU	11/04/14
CHECKED BY:	SBU	11/04/14
APPROVED BY:	SBU	11/04/14
DRAWING NO.	TCVC14341CSP	
PLATI	E 5	



TEST TRENCH #3
EAST HALF



TEST TRENCH #3
WEST HALF

PHOTOGRAPHS DEPICT CONDITION OF THE SUBJECT PROPERTY AS OF NOVEMBER 03, 2014



PROPERTY PHOTOGRAPHS

EAST PORTION OF PARCEL 307-D-001 CENTER STREET PARCEL McKEESPORT, PENNSYLVANIA

DRAWN BY:	SBU	11/04/14
CHECKED BY:	SBU	11/04/14
APPROVED BY:	SBU	11/04/14
DRAWING NO.	TCVC14341CSP	
PLATI	E 6	



TEST TRENCH #3 LOOKING EAST FROM WEST END



TEST TRENCH #1 SOUTH STARTING POINT

PHOTOGRAPHS DEPICT CONDITION OF THE SUBJECT PROPERTY AS OF NOVEMBER 03, 2014



PROPERTY PHOTOGRAPHS

EAST PORTION OF PARCEL 307-D-001 CENTER STREET PARCEL MCKEESPORT, PENNSYLVANIA

DRAWN BY:	SBU	11/04/14
CHECKED BY:	SBU	11/04/14
APPROVED BY:	SBU	11/04/14
DRAWING NO.	TCVC14341CSP	
PLATI	E 7	



TEST TRENCH #1
SOUTH END



TEST TRENCH #1
NORTH END

PHOTOGRAPHS DEPICT CONDITION OF THE SUBJECT PROPERTY AS OF NOVEMBER 03, 2014



PROPERTY PHOTOGRAPHS

EAST PORTION OF PARCEL 307-D-001 CENTER STREET PARCEL McKEESPORT, PENNSYLVANIA

DRAWN BY:	SBU	11/04/14
CHECKED BY:	SBU	11/04/14
APPROVED BY:	SBU	11/04/14
DRAWING NO.	TCVC14341CSP	
PLATI	E 8	



TEST TRENCH #1
CENTRAL PORTION



TEST TRENCH #2 NORTH STARTING POINT

PHOTOGRAPHS DEPICT CONDITION OF THE SUBJECT PROPERTY AS OF NOVEMBER 03, 2014



PROPERTY PHOTOGRAPHS

EAST PORTION OF PARCEL 307-D-001 CENTER STREET PARCEL MCKEESPORT, PENNSYLVANIA

DRAWN BY:	SBU	11/04/14
CHECKED BY:	SBU	11/04/14
APPROVED BY:	SBU	11/04/14
DRAWING NO.	TCVC	14341CSP
PLATI	E 9	



TEST TRENCH #2 NORTH END



TEST TRENCH #2
CENTRAL PORTION

PHOTOGRAPHS DEPICT CONDITION OF THE SUBJECT PROPERTY AS OF NOVEMBER 03, 2014



PROPERTY PHOTOGRAPHS

EAST PORTION OF PARCEL 307-D-001 CENTER STREET PARCEL McKEESPORT, PENNSYLVANIA

DRAWN BY:	SBU	11/04/14
CHECKED BY:	SBU	11/04/14
APPROVED BY:	SBU	11/04/14
DRAWING NO.	TCVC	14341CSP
PLATE	10	



TEST TRENCH #2 SOUTH END



TEST TRENCH #2 LOOKING NORTH FROM SOUTH

PHOTOGRAPHS DEPICT CONDITION OF THE SUBJECT PROPERTY AS OF NOVEMBER 03, 2014



PROPERTY PHOTOGRAPHS

EAST PORTION OF PARCEL 307-D-001 CENTER STREET PARCEL McKEESPORT, PENNSYLVANIA

DRAWN BY:	SBU	11/04/14
CHECKED BY:	SBU	11/04/14
APPROVED BY:	SBU	11/04/14
DRAWING NO.	TCVC	14341CSP
PLATE	11	

Appendix D Laboratory Analytical Results





THE LEADER IN ENVIRONMENTAL TESTING

ANALYTICAL REPORT

TestAmerica Laboratories, Inc.

TestAmerica Pittsburgh 301 Alpha Drive RIDC Park Pittsburgh, PA 15238 Tel: (412)963-7058

TestAmerica Job ID: 180-38441-1

Client Project/Site: Center Street Parcel, McKeesport, PA TCV

For:

KU Resources Inc 22 South Linden Street Duquesne, Pennsylvania 15110

Attn: Ms. Sara Uhl

Carw G. Camber

Authorized for release by: 11/17/2014 10:24:49 AM

Carrie Gamber, Senior Project Manager (412)963-2428

carrie.gamber@testamericainc.com

·····LINKS ·······

Review your project results through

Total Access

Have a Question?



Visit us at: www.testamericainc.com

This report has been electronically signed and authorized by the signatory. Electronic signature is intended to be the legally binding equivalent of a traditionally handwritten signature.

Results relate only to the items tested and the sample(s) as received by the laboratory.

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Case Narrative

Client: KU Resources Inc

Project/Site: Center Street Parcel, McKeesport, PA TCV

TestAmerica Job ID: 180-38441-1

Job ID: 180-38441-1

Laboratory: TestAmerica Pittsburgh

Narrative

CASE NARRATIVE

Client: KU Resources Inc

Project: Center Street Parcel, McKeesport, PA TCV

Report Number: 180-38441-1

With the exceptions noted as flags or footnotes, standard analytical protocols were followed in the analysis of the samples and no problems were encountered or anomalies observed. In addition all laboratory quality control samples were within established control limits, with any exceptions noted below. Each sample was analyzed to achieve the lowest possible reporting limit within the constraints of the method. In some cases, due to interference or analytes present at high concentrations, samples were diluted. For diluted samples, the reporting limits are adjusted relative to the dilution required.

Calculations are performed before rounding to avoid round-off errors in calculated results.

All holding times were met and proper preservation noted for the methods performed on these samples, unless otherwise detailed in the individual sections below.

RECEIPT

The samples were received on 11/03/2014; the samples arrived in good condition, properly preserved and on ice. The temperature of the coolers at receipt was 3.5 C.

BNA

The following samples were diluted due to the nature of the sample matrix: TT-02A (180-38441-3), TT-02B (180-38441-4), TT-02B (180-38441-4 MSD). Elevated reporting limits (RLs) are provided. The sample extracts were too viscous to be analyzed at any less of a dilution.

2,4-Dimethylphenol failed the recovery criteria low for the MS/MSD of sample TT-02B (180-38441-4) in batch 180-124983.

PCB

No analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

PERCENT SOLIDS

No analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

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Definitions/Glossary

Client: KU Resources Inc

Project/Site: Center Street Parcel, McKeesport, PA TCV

TestAmerica Job ID: 180-38441-1

Qualifiers

GC/MS Semi VOA

Qualifier	Qualifier Description
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.
F1	MS and/or MSD Recovery exceeds the control limits

Glossary

QC

RER

RPD

TEF

TEQ

RL

Quality Control

Relative error ratio

Toxicity Equivalent Factor (Dioxin)

Toxicity Equivalent Quotient (Dioxin)

Reporting Limit or Requested Limit (Radiochemistry)

Relative Percent Difference, a measure of the relative difference between two points

Abbreviation	These commonly used abbreviations may or may not be present in this report.
¤	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CFL	Contains Free Liquid
CNF	Contains no Free Liquid
DER	Duplicate error ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision level concentration
MDA	Minimum detectable activity
EDL	Estimated Detection Limit
MDC	Minimum detectable concentration
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
NC	Not Calculated
ND	Not detected at the reporting limit (or MDL or EDL if shown)
PQL	Practical Quantitation Limit

Certification Summary

Client: KU Resources Inc TestAmerica Job ID: 180-38441-1

Project/Site: Center Street Parcel, McKeesport, PA TCV

Laboratory: TestAmerica Pittsburgh

Unless otherwise noted, all analytes for this laboratory were covered under each certification below.

Authority	Program	Program		Certification ID	Expiration Date		
Pennsylvania	NELAP	NELAP		02-00416	04-30-15		
Analysis Method	Prep Method	Matrix	Analyt	te			

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Sample Summary

Client: KU Resources Inc

Project/Site: Center Street Parcel, McKeesport, PA TCV

TestAmerica Job ID: 180-38441-1

Lab Sample ID	Client Sample ID	Matrix	Collected	Received
180-38441-1	TT-01A	Solid	10/28/14 11:15	11/03/14 16:10
180-38441-2	TT-01B	Solid	10/28/14 11:30	11/03/14 16:10
180-38441-3	TT-02A	Solid	10/28/14 12:00	11/03/14 16:10
180-38441-4	TT-02B	Solid	10/28/14 12:15	11/03/14 16:10
180-38441-5	TT-03A	Solid	10/28/14 10:45	11/03/14 16:10
180-38441-6	TT-03B	Solid	10/28/14 11:00	11/03/14 16:10
180-38441-7	TT-04A	Solid	10/28/14 10:00	11/03/14 16:10
180-38441-8	TT-04B	Solid	10/28/14 10:30	11/03/14 16:10

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Method Summary

Client: KU Resources Inc

Project/Site: Center Street Parcel, McKeesport, PA TCV

TestAmerica Job ID: 180-38441-1

Method	Method Description	Protocol	Laboratory
8270D	Semivolatile Organic Compounds (GC/MS)	SW846	TAL PIT
8082A	Polychlorinated Biphenyls (PCBs) by Gas Chromatography	SW846	TAL PIT
2540G	SM 2540G	SM22	TAL PIT

Protocol References:

SM22 = SM22

SW846 = "Test Methods For Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 And Its Updates.

Laboratory References:

TAL PIT = TestAmerica Pittsburgh, 301 Alpha Drive, RIDC Park, Pittsburgh, PA 15238, TEL (412)963-7058

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1:

Client: KU Resources Inc

Project/Site: Center Street Parcel, McKeesport, PA TCV

Client Sample ID: TT-01A

Date Collected: 10/28/14 11:15

Lab Sample ID: TT-01A

Date Received: 11/03/14 16:10

Lab Sample ID: 180-38441-1

Matrix: Solid

Percent Solids: 88.5

	Batch	Batch		Dil	Initial	Final	Batch	Prepared		
Prep Type	Type	Method	Run	Factor	Amount	Amount	Number	or Analyzed	Analyst	Lab
Total/NA	Prep	3541			15.0 g	5.0 mL	123937	11/05/14 03:00	KLG	TAL PIT
Total/NA	Analysis	8270D		1	15.0 g	5.0 mL	124983	11/13/14 15:39	VVP	TAL PIT
	Instrume	ent ID: CH731								
Total/NA	Prep	3541			15.0 g	20.0 mL	124106	11/06/14 03:45	KLG	TAL PIT
Total/NA	Analysis	8082A		1	15.0 g	20.0 mL	124338	11/08/14 02:07	AKG	TAL PIT
	Instrume	ent ID: CHGC10								
Total/NA	Analysis	2540G		1			124046	11/05/14 15:02	AB1	TAL PIT
	Instrume	ent ID: NOEQUIP								

Client Sample ID: TT-01B

Date Collected: 10/28/14 11:30

Date Received: 11/03/14 16:10

Lab Sample ID: 180-38441-2

Percent Solids: 89.3

Matrix: Solid

	Batch	Batch		Dil	Initial	Final	Batch	Prepared		
Prep Type	Type	Method	Run	Factor	Amount	Amount	Number	or Analyzed	Analyst	Lab
Total/NA	Prep	3541			15.0 g	5.0 mL	123937	11/05/14 03:00	KLG	TAL PIT
Total/NA	Analysis	8270D		1	15.0 g	5.0 mL	125132	11/14/14 13:57	VVP	TAL PIT
	Instrume	ent ID: CH731								
Total/NA	Prep	3541			15.0 g	20.0 mL	124106	11/06/14 03:45	KLG	TAL PIT
Total/NA	Analysis	8082A		1	15.0 g	20.0 mL	124338	11/08/14 02:39	AKG	TAL PIT
	Instrume	ent ID: CHGC10								
Total/NA	Analysis	2540G		1			124046	11/05/14 15:02	AB1	TAL PIT
	Instrume	ent ID: NOEQUIP								

Client Sample ID: TT-02A

Date Collected: 10/28/14 12:00

Date Received: 11/03/14 16:10

Lab Sample ID: 180-38441-3

Matrix: Solid Percent Solids: 89.6

	Batch	Batch		Dil	Initial	Final	Batch	Prepared		
Prep Type	Type	Method	Run	Factor	Amount	Amount	Number	or Analyzed	Analyst	Lab
Total/NA	Prep	3541			15.1 g	5.0 mL	123937	11/05/14 03:00	KLG	TAL PIT
Total/NA	Analysis	8270D		2	15.1 g	5.0 mL	124983	11/13/14 16:38	VVP	TAL PIT
	Instrume	ent ID: CH731								
Total/NA	Prep	3541			15.1 g	20.0 mL	124106	11/06/14 03:45	KLG	TAL PIT
Total/NA	Analysis	8082A		1	15.1 g	20.0 mL	124338	11/08/14 03:10	AKG	TAL PIT
	Instrume	ent ID: CHGC10								
Total/NA	Analysis	2540G		1			124046	11/05/14 15:02	AB1	TAL PIT
	Instrume	ent ID: NOEQUIP								

Client Sample ID: TT-02B

Date Collected: 10/28/14 12:15

Date Received: 11/03/14 16:10

Lab Sample ID: 180-38441-4

Matrix: Solid

Percent Solids: 87.6

	Batch	Batch		Dil	Initial	Final	Batch	Prepared		
Prep Type	Туре	Method	Run	Factor	Amount	Amount	Number	or Analyzed	Analyst	Lab
Total/NA	Prep	3541			15.1 g	5.0 mL	123937	11/05/14 03:00	KLG	TAL PIT

TestAmerica Pittsburgh

Lab Chronicle

Client: KU Resources Inc

Project/Site: Center Street Parcel, McKeesport, PA TCV

TestAmerica Job ID: 180-38441-1

Client Sample ID: TT-02B

Date Collected: 10/28/14 12:15 Date Received: 11/03/14 16:10

Lab Sample ID: 180-38441-4 Matrix: Solid

Percent Solids: 87.6

	Batch	Batch		Dil	Initial	Final	Batch	Prepared		
Prep Type	Type	Method	Run	Factor	Amount	Amount	Number	or Analyzed	Analyst	Lab
Total/NA	Analysis	8270D	<u> </u>	2	15.1 g	5.0 mL	124983	11/13/14 17:07	VVP	TAL PIT
	Instrume	ent ID: CH731								
Total/NA	Prep	3541			15.1 g	20.0 mL	124106	11/06/14 03:45	KLG	TAL PIT
Total/NA	Analysis	8082A		1	15.1 g	20.0 mL	124338	11/08/14 03:41	AKG	TAL PIT
	Instrume	ent ID: CHGC10								
Total/NA	Analysis	2540G		1			124046	11/05/14 15:02	AB1	TAL PIT
	Instrume	ent ID: NOEQUIP								

Client Sample ID: TT-03A Lab Sample ID: 180-38441-5

Date Collected: 10/28/14 10:45 **Matrix: Solid** Date Received: 11/03/14 16:10 Percent Solids: 87.2

	Batch	Batch		Dil	Initial	Final	Batch	Prepared		
Prep Type	Type	Method	Run	Factor	Amount	Amount	Number	or Analyzed	Analyst	Lab
Total/NA	Prep	3541			15.0 g	5.0 mL	123937	11/05/14 03:00	KLG	TAL PIT
Total/NA	Analysis Instrume	8270D ent ID: CH731		1	15.0 g	5.0 mL	124983	11/13/14 18:34	VVP	TAL PIT
Total/NA	Prep	3541			15.0 g	20.0 mL	124106	11/06/14 03:45	KLG	TAL PIT
Total/NA	Analysis Instrume	8082A ent ID: CHGC10		1	15.0 g	20.0 mL	124338	11/08/14 05:15	AKG	TAL PIT
Total/NA	Analysis Instrume	2540G ent ID: NOEQUIP		1			124046	11/05/14 15:02	AB1	TAL PIT

Client Sample ID: TT-03B Lab Sample ID: 180-38441-6

Date Collected: 10/28/14 11:00 Date Received: 11/03/14 16:10 Percent Solids: 87.5

	Batch	Batch		Dil	Initial	Final	Batch	Prepared		
Prep Type	Type	Method	Run	Factor	Amount	Amount	Number	or Analyzed	Analyst	Lab
Total/NA	Prep	3541			15.0 g	5.0 mL	123937	11/05/14 03:00	KLG	TAL PIT
Total/NA	Analysis	8270D		1	15.0 g	5.0 mL	124983	11/13/14 19:03	VVP	TAL PIT
	Instrume	ent ID: CH731								
Total/NA	Prep	3541			15.0 g	20.0 mL	124106	11/06/14 03:45	KLG	TAL PIT
Total/NA	Analysis	8082A		1	15.0 g	20.0 mL	124338	11/08/14 05:47	AKG	TAL PIT
	Instrume	ent ID: CHGC10								
Total/NA	Analysis	2540G		1			124046	11/05/14 15:02	AB1	TAL PIT
	Instrume	ent ID: NOEQUIP								

Client Sample ID: TT-04A Lab Sample ID: 180-38441-7

Date Collected: 10/28/14 10:00 **Matrix: Solid** Date Received: 11/03/14 16:10 Percent Solids: 90.6

_	Batch	Batch		Dil	Initial	Final	Batch	Prepared		
Prep Type	Type	Method	Run	Factor	Amount	Amount	Number	or Analyzed	Analyst	Lab
Total/NA	Prep	3541			15.1 g	5.0 mL	123937	11/05/14 03:00	KLG	TAL PIT

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Matrix: Solid

TestAmerica Pittsburgh

Lab Chronicle

Client: KU Resources Inc

Project/Site: Center Street Parcel, McKeesport, PA TCV

TestAmerica Job ID: 180-38441-1

Lab Sample ID: 180-38441-7

Client Sample ID: TT-04A Date Collected: 10/28/14 10:00 Matrix: Solid Percent Solids: 90.6 Date Received: 11/03/14 16:10

	Batch	Batch		Dil	Initial	Final	Batch	Prepared		
Prep Type	Type	Method	Run	Factor	Amount	Amount	Number	or Analyzed	Analyst	Lab
Total/NA	Analysis	8270D		1	15.1 g	5.0 mL	124983	11/13/14 19:32	VVP	TAL PIT
	Instrume	ent ID: CH731								
Total/NA	Prep	3541			15.2 g	20.0 mL	124106	11/06/14 03:45	KLG	TAL PIT
Total/NA	Analysis	8082A		1	15.2 g	20.0 mL	124338	11/08/14 06:18	AKG	TAL PIT
	Instrume	ent ID: CHGC10								
Total/NA	Analysis	2540G		1			124046	11/05/14 15:02	AB1	TAL PIT
	Instrume	ent ID: NOEQUIP								

Client Sample ID: TT-04B Lab Sample ID: 180-38441-8

Date Collected: 10/28/14 10:30 **Matrix: Solid** Date Received: 11/03/14 16:10 Percent Solids: 89.8

	Batch	Batch		Dil	Initial	Final	Batch	Prepared		
Prep Type	Type	Method	Run	Factor	Amount	Amount	Number	or Analyzed	Analyst	Lab
Total/NA	Prep	3541			15.0 g	5.0 mL	123937	11/05/14 03:00	KLG	TAL PIT
Total/NA	Analysis	8270D		1	15.0 g	5.0 mL	124983	11/13/14 20:01	VVP	TAL PIT
	Instrume	ent ID: CH731								
Total/NA	Prep	3541			15.0 g	20.0 mL	124106	11/06/14 03:45	KLG	TAL PIT
Total/NA	Analysis	8082A		1	15.0 g	20.0 mL	124338	11/08/14 06:50	AKG	TAL PIT
	Instrume	ent ID: CHGC10								
Total/NA	Analysis	2540G		1			124046	11/05/14 15:02	AB1	TAL PIT
	Instrume	ent ID: NOEQUIP								

Laboratory References:

TAL PIT = TestAmerica Pittsburgh, 301 Alpha Drive, RIDC Park, Pittsburgh, PA 15238, TEL (412)963-7058

Analyst References:

Lab: TAL PIT

Batch Type: Prep

KLG = Kevin Geehring

Batch Type: Analysis

AB1 = Ashwin Baikadi

AKG = Ashok Gupta

VVP = Vincent Piccolino

TestAmerica Pittsburgh

Client: KU Resources Inc

Client Sample ID: TT-01A

Date Collected: 10/28/14 11:15

Date Received: 11/03/14 16:10

Project/Site: Center Street Parcel, McKeesport, PA TCV

TestAmerica Job ID: 180-38441-1

Lab Sample ID: 180-38441-1 Matrix: Solid

Percent Solids: 88.5

Analyte	rganic Compou Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fa
Acenaphthene	25		76	7.2	ug/Kg		11/05/14 03:00	11/13/14 15:39	
Acenaphthylene	99		76	8.6	ug/Kg	₩	11/05/14 03:00	11/13/14 15:39	
Anthracene	110		76	7.4	ug/Kg	₽	11/05/14 03:00	11/13/14 15:39	
Benzo[a]anthracene	590		76	9.4	ug/Kg		11/05/14 03:00	11/13/14 15:39	
Benzo[a]pyrene	560		76	7.5	ug/Kg	₽	11/05/14 03:00	11/13/14 15:39	
Benzo[b]fluoranthene	830		76		ug/Kg	₩	11/05/14 03:00	11/13/14 15:39	
Benzo[g,h,i]perylene	580		76		ug/Kg		11/05/14 03:00	11/13/14 15:39	
Benzo[k]fluoranthene	390		76		ug/Kg	₩	11/05/14 03:00	11/13/14 15:39	
Bis(2-ethylhexyl) phthalate	ND		760	61	ug/Kg ug/Kg	₽	11/05/14 03:00	11/13/14 15:39	
2,2'-oxybis[1-chloropropane]	ND		76	8.1			11/05/14 03:00	11/13/14 15:39	
4-Bromophenyl phenyl ether	ND		370	33	ug/Kg ug/Kg		11/05/14 03:00	11/13/14 15:39	
	ND ND		370	52	ug/Kg ug/Kg		11/05/14 03:00	11/13/14 15:39	
Butyl benzyl phthalate			76						
Carbazole	44	J			ug/Kg ug/Kg	₩	11/05/14 03:00	11/13/14 15:39	
4-Chloroaniline	ND		370	30		₩	11/05/14 03:00	11/13/14 15:39	
2-Chloronaphthalene	ND		76	7.9	ug/Kg		11/05/14 03:00	11/13/14 15:39	
4-Chlorophenyl phenyl ether	ND		370		ug/Kg	*	11/05/14 03:00	11/13/14 15:39	
Chrysene	700		76	9.0	ug/Kg	₩	11/05/14 03:00	11/13/14 15:39	
Dibenz(a,h)anthracene	120		76	8.4	ug/Kg		11/05/14 03:00	11/13/14 15:39	
Dibenzofuran	60	J	370	37	ug/Kg	₩	11/05/14 03:00	11/13/14 15:39	
Di-n-butyl phthalate	ND		370	47	ug/Kg	*	11/05/14 03:00	11/13/14 15:39	
3,3'-Dichlorobenzidine	ND		370	40	ug/Kg		11/05/14 03:00	11/13/14 15:39	
Diethyl phthalate	120	J	370	41	ug/Kg	₩	11/05/14 03:00	11/13/14 15:39	
Dimethyl phthalate	ND		370	41	ug/Kg	₩	11/05/14 03:00	11/13/14 15:39	
2,4-Dinitrotoluene	ND		370	30	ug/Kg		11/05/14 03:00	11/13/14 15:39	
2,6-Dinitrotoluene	ND		370	39	ug/Kg	₽	11/05/14 03:00	11/13/14 15:39	
Di-n-octyl phthalate	ND		370	40	ug/Kg	₩	11/05/14 03:00	11/13/14 15:39	
Fluoranthene	930		76	8.1	ug/Kg	₩	11/05/14 03:00	11/13/14 15:39	
Fluorene	29	J	76	9.9	ug/Kg	₩	11/05/14 03:00	11/13/14 15:39	
Hexachlorobenzene	ND		76	8.0	ug/Kg	₩	11/05/14 03:00	11/13/14 15:39	
Hexachlorobutadiene	ND		76	8.4	ug/Kg	₩	11/05/14 03:00	11/13/14 15:39	
Hexachlorocyclopentadiene	ND		370	41	ug/Kg	*	11/05/14 03:00	11/13/14 15:39	
Hexachloroethane	ND		370	27	ug/Kg	₽	11/05/14 03:00	11/13/14 15:39	
Indeno[1,2,3-cd]pyrene	470		76	7.8	ug/Kg	₩	11/05/14 03:00	11/13/14 15:39	
Isophorone	ND		370	28	ug/Kg	₩.	11/05/14 03:00	11/13/14 15:39	
2-Methylnaphthalene	74	J	76	6.8	ug/Kg	₽	11/05/14 03:00	11/13/14 15:39	
Naphthalene	160		76		ug/Kg	₽	11/05/14 03:00	11/13/14 15:39	
2-Nitroaniline	ND		1900		ug/Kg		11/05/14 03:00	11/13/14 15:39	
3-Nitroaniline	ND		1900	160	ug/Kg	₽	11/05/14 03:00	11/13/14 15:39	
4-Nitroaniline	ND		1900	150	ug/Kg	₽	11/05/14 03:00	11/13/14 15:39	
4-Nitrophenol	ND		1900	140	ug/Kg		11/05/14 03:00	11/13/14 15:39	
Nitrobenzene	ND		760	31	ug/Kg	₽	11/05/14 03:00	11/13/14 15:39	
N-Nitrosodi-n-propylamine	ND		76	8.8	ug/Kg ug/Kg	₽	11/05/14 03:00	11/13/14 15:39	
N-Nitrosodi-n-propylamine	ND		370		ug/Kg		11/05/14 03:00	11/13/14 15:39	
Phenanthrene	450		76		ug/Kg ug/Kg	₽	11/05/14 03:00	11/13/14 15:39	
			76 76			₽			
Pyrene 4 Chloro 3 methylphonol	800				ug/Kg	· · · · · · *	11/05/14 03:00	11/13/14 15:39	
4-Chloro-3-methylphenol	ND ND		370 370		ug/Kg		11/05/14 03:00	11/13/14 15:39	
2-Chlorophenol	ND		370		ug/Kg	₽ **	11/05/14 03:00	11/13/14 15:39	
2-Methylphenol	ND		370	26	ug/Kg	₩	11/05/14 03:00	11/13/14 15:39	

TestAmerica Pittsburgh

11/17/2014

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Project/Site: Center Street Parcel, McKeesport, PA TCV

Client Sample ID: TT-01A

Client: KU Resources Inc

Lab Sample ID: 180-38441-1 Date Collected: 10/28/14 11:15

Matrix: Solid Percent Solids: 88.5

Date Received: 11/03/14 16:10

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
2,4-Dichlorophenol	ND		76	7.6	ug/Kg	<u> </u>	11/05/14 03:00	11/13/14 15:39	1
2,4-Dimethylphenol	ND		370	59	ug/Kg	₽	11/05/14 03:00	11/13/14 15:39	1
2,4-Dinitrophenol	ND		1900	450	ug/Kg	₽	11/05/14 03:00	11/13/14 15:39	1
4,6-Dinitro-2-methylphenol	ND		1900	150	ug/Kg	₽	11/05/14 03:00	11/13/14 15:39	1
2-Nitrophenol	ND		370	42	ug/Kg	₽	11/05/14 03:00	11/13/14 15:39	1
Pentachlorophenol	ND		370	34	ug/Kg	₽	11/05/14 03:00	11/13/14 15:39	1
Phenol	ND		76	8.9	ug/Kg	₽	11/05/14 03:00	11/13/14 15:39	1
2,4,5-Trichlorophenol	ND		370	40	ug/Kg	₽	11/05/14 03:00	11/13/14 15:39	1
2,4,6-Trichlorophenol	ND		370	56	ug/Kg	₽	11/05/14 03:00	11/13/14 15:39	1
Acetophenone	ND		370	31	ug/Kg	₽	11/05/14 03:00	11/13/14 15:39	1
Atrazine	ND		370	37	ug/Kg	₽	11/05/14 03:00	11/13/14 15:39	1
Benzaldehyde	ND		370	57	ug/Kg	₽	11/05/14 03:00	11/13/14 15:39	1
1,1'-Biphenyl	ND		370	34	ug/Kg	₽	11/05/14 03:00	11/13/14 15:39	1
Caprolactam	ND		1900	280	ug/Kg	₽	11/05/14 03:00	11/13/14 15:39	1
Bis(2-chloroethoxy)methane	ND		370	25	ug/Kg	\$	11/05/14 03:00	11/13/14 15:39	1
Bis(2-chloroethyl)ether	ND		76	10	ug/Kg	₽	11/05/14 03:00	11/13/14 15:39	1

Surrogate	%Recovery Q	Qualifier Li	mits	Prepared	Analyzed	Dil Fac
Nitrobenzene-d5 (Surr)	79	25	5 - 104	11/05/14 03:00	11/13/14 15:39	1
Phenol-d5 (Surr)	63	25	5 - 105	11/05/14 03:00	11/13/14 15:39	1
2-Fluorobiphenyl	70	35	5 - 105	11/05/14 03:00	11/13/14 15:39	1
2,4,6-Tribromophenol (Surr)	51	35	5 - 124	11/05/14 03:00	11/13/14 15:39	1
2-Fluorophenol (Surr)	58	39	- 103	11/05/14 03:00	11/13/14 15:39	1
Terphenyl-d14 (Surr)	61	25	5 - 127	11/05/14 03:00	11/13/14 15:39	1

Method: 8082A - Polychlorinated	Biphenyls (PCBs) k	by Gas Chromatography
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Analyte	Result Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
PCB-1016	ND	19	3.8	ug/Kg	\	11/06/14 03:45	11/08/14 02:07	1
PCB-1221	ND	19	4.7	ug/Kg	₽	11/06/14 03:45	11/08/14 02:07	1
PCB-1232	ND	19	6.5	ug/Kg	₽	11/06/14 03:45	11/08/14 02:07	1
PCB-1242	ND	19	4.8	ug/Kg	₽	11/06/14 03:45	11/08/14 02:07	1
PCB-1248	ND	19	4.7	ug/Kg	₽	11/06/14 03:45	11/08/14 02:07	1
PCB-1254	570	19	4.5	ug/Kg	₽	11/06/14 03:45	11/08/14 02:07	1
PCB-1260	97	19	4.1	ug/Kg	₽	11/06/14 03:45	11/08/14 02:07	1

Surrogate	%Recovery Qualifier	Limits	Prepared	Analyzed	Dil Fac
Tetrachloro-m-xylene (Surr)	65	45 - 135	11/06/14 03:45	11/08/14 02:07	1
DCB Decachlorobiphenyl (Surr)	7.3	45 - 125	11/06/14 03:45	11/08/14 02:07	1

General	Chemi	stry
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Analyte		Qualifier RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Percent Moisture	12	0.10	0.10	%			11/05/14 15:02	1

Client Sample ID: TT-01B Lab Sample ID: 180-38441-2

Date Collected: 10/28/14 11:30

Matrix: Solid

Date Received: 11/03/14 16:10 Percent Solids: 89.3

Method: 8270D - Semivolatile Orga	nic Compou	nds (GC/MS	S)						
Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Acenaphthene	22	J	75	7.2	ug/Kg	<u> </u>	11/05/14 03:00	11/14/14 13:57	1
Acenaphthylene	43	J	75	8.6	ug/Kg	#	11/05/14 03:00	11/14/14 13:57	1

TestAmerica Pittsburgh

Client: KU Resources Inc

Project/Site: Center Street Parcel, McKeesport, PA TCV

Client Sample ID: TT-01B

Date Collected: 10/28/14 11:30 Date Received: 11/03/14 16:10 Lab Sample ID: 180-38441-2

TestAmerica Job ID: 180-38441-1

Matrix: Solid

Percent Solids: 89.3

Method: 8270D - Semivolatile O Analyte		Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Anthracene	96		75	7.3	ug/Kg	<u> </u>	11/05/14 03:00	11/14/14 13:57	1
Benzo[a]anthracene	660		75	9.4	ug/Kg		11/05/14 03:00	11/14/14 13:57	1
Benzo[a]pyrene	610		75	7.5	ug/Kg	₽	11/05/14 03:00	11/14/14 13:57	1
Benzo[b]fluoranthene	920		75	12	ug/Kg	₽	11/05/14 03:00	11/14/14 13:57	1
Benzo[g,h,i]perylene	510		75	7.4	ug/Kg		11/05/14 03:00	11/14/14 13:57	1
Benzo[k]fluoranthene	310		75	15	ug/Kg	₽	11/05/14 03:00	11/14/14 13:57	1
Bis(2-ethylhexyl) phthalate	ND		750	60	ug/Kg	₽	11/05/14 03:00	11/14/14 13:57	1
2,2'-oxybis[1-chloropropane]	ND		75	8.1	ug/Kg		11/05/14 03:00	11/14/14 13:57	1
4-Bromophenyl phenyl ether	ND		370	32	ug/Kg	₽	11/05/14 03:00	11/14/14 13:57	1
Butyl benzyl phthalate	ND		370	51	ug/Kg	₽	11/05/14 03:00	11/14/14 13:57	1
Carbazole	65		75	6.9	ug/Kg		11/05/14 03:00	11/14/14 13:57	1
4-Chloroaniline	ND		370	30	ug/Kg	₽	11/05/14 03:00	11/14/14 13:57	1
2-Chloronaphthalene	ND		75	7.8	ug/Kg	₽	11/05/14 03:00	11/14/14 13:57	1
4-Chlorophenyl phenyl ether	ND		370		ug/Kg		11/05/14 03:00	11/14/14 13:57	· · · · · · · · · · · · · · · · · · ·
Chrysene	710		75	8.9	ug/Kg	₽	11/05/14 03:00	11/14/14 13:57	. 1
Dibenz(a,h)anthracene	110		75 75	8.3	ug/Kg ug/Kg	₩	11/05/14 03:00	11/14/14 13:57	1
			370	37	ug/Kg ug/Kg	· · · · · · · · · · · · · · · · · · ·	11/05/14 03:00	11/14/14 13:57	1
Dibenzofuran Di p butul phtholato	51 ND	J	370	47	ug/Kg ug/Kg	₩	11/05/14 03:00	11/14/14 13:57	1
Di-n-butyl phthalate	ND ND		370			~ ☆			1 1
3,3'-Dichlorobenzidine				39	ug/Kg ug/Kg		11/05/14 03:00	11/14/14 13:57	
Diethyl phthalate	ND		370			₩	11/05/14 03:00	11/14/14 13:57	•
Dimethyl phthalate	ND		370	41	ug/Kg	₩	11/05/14 03:00	11/14/14 13:57	1
2,4-Dinitrotoluene	ND		370	30	ug/Kg		11/05/14 03:00	11/14/14 13:57	1
2,6-Dinitrotoluene	ND		370		ug/Kg	\$	11/05/14 03:00	11/14/14 13:57	1
Di-n-octyl phthalate	ND		370	39	ug/Kg	₩.	11/05/14 03:00	11/14/14 13:57	1
Fluoranthene	800		75	8.0	ug/Kg	T.	11/05/14 03:00	11/14/14 13:57	
Fluorene	29	J	75	9.8	ug/Kg	₩.	11/05/14 03:00	11/14/14 13:57	1
Hexachlorobenzene	ND		75	8.0	ug/Kg	₩	11/05/14 03:00	11/14/14 13:57	1
Hexachlorobutadiene	ND		75	8.4		<u>.</u> .	11/05/14 03:00	11/14/14 13:57	1
Hexachlorocyclopentadiene	ND		370	40	ug/Kg	*	11/05/14 03:00	11/14/14 13:57	1
Hexachloroethane	ND		370	27	ug/Kg	₽	11/05/14 03:00	11/14/14 13:57	1
Indeno[1,2,3-cd]pyrene	420		75	7.7	ug/Kg		11/05/14 03:00	11/14/14 13:57	1
Isophorone	ND		370	28	ug/Kg	₽	11/05/14 03:00	11/14/14 13:57	1
2-Methylnaphthalene	81		75	6.7	ug/Kg	₽	11/05/14 03:00	11/14/14 13:57	1
Naphthalene	110		75	6.4	ug/Kg	₽	11/05/14 03:00	11/14/14 13:57	1
2-Nitroaniline	ND		1900	170	ug/Kg	₽	11/05/14 03:00	11/14/14 13:57	1
3-Nitroaniline	ND		1900	150	ug/Kg	₩	11/05/14 03:00	11/14/14 13:57	1
4-Nitroaniline	ND		1900	150	ug/Kg	≎	11/05/14 03:00	11/14/14 13:57	1
4-Nitrophenol	ND		1900	140	ug/Kg	₽	11/05/14 03:00	11/14/14 13:57	1
Nitrobenzene	ND		750	31	ug/Kg	₽	11/05/14 03:00	11/14/14 13:57	1
N-Nitrosodi-n-propylamine	ND		75	8.8	ug/Kg	₽	11/05/14 03:00	11/14/14 13:57	1
N-Nitrosodiphenylamine	ND		370	35	ug/Kg		11/05/14 03:00	11/14/14 13:57	1
Phenanthrene	550		75	12	ug/Kg	₽	11/05/14 03:00	11/14/14 13:57	1
Pyrene	970		75	7.6	ug/Kg	₽	11/05/14 03:00	11/14/14 13:57	1
4-Chloro-3-methylphenol	ND		370		ug/Kg		11/05/14 03:00	11/14/14 13:57	1
2-Chlorophenol	ND		370		ug/Kg	₩	11/05/14 03:00	11/14/14 13:57	1
2-Methylphenol	ND		370		ug/Kg	₩	11/05/14 03:00	11/14/14 13:57	1
- · j · p · · · · · · · · ·	.15								
Methylphenol, 3 & 4	ND		370	37	ua/Ka		11/05/14 03:00	11/14/14 13:57	1
Methylphenol, 3 & 4 2,4-Dichlorophenol	ND ND		370 75		ug/Kg ug/Kg	\$	11/05/14 03:00 11/05/14 03:00	11/14/14 13:57 11/14/14 13:57	1 1

TestAmerica Pittsburgh

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Client: KU Resources Inc

Project/Site: Center Street Parcel, McKeesport, PA TCV

Client Sample ID: TT-01B

Date Collected: 10/28/14 11:30 Date Received: 11/03/14 16:10 Lab Sample ID: 180-38441-2

Matrix: Solid

Percent Solids: 89.3

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
2,4-Dinitrophenol	ND		1900	440	ug/Kg	<u></u>	11/05/14 03:00	11/14/14 13:57	1
4,6-Dinitro-2-methylphenol	ND		1900	150	ug/Kg	₽	11/05/14 03:00	11/14/14 13:57	1
2-Nitrophenol	ND		370	41	ug/Kg	₽	11/05/14 03:00	11/14/14 13:57	1
Pentachlorophenol	ND		370	33	ug/Kg	\$	11/05/14 03:00	11/14/14 13:57	1
Phenol	ND		75	8.8	ug/Kg	₩	11/05/14 03:00	11/14/14 13:57	1
2,4,5-Trichlorophenol	ND		370	40	ug/Kg	₩	11/05/14 03:00	11/14/14 13:57	1
2,4,6-Trichlorophenol	ND		370	56	ug/Kg	\$	11/05/14 03:00	11/14/14 13:57	1
Acetophenone	ND		370	31	ug/Kg	₩	11/05/14 03:00	11/14/14 13:57	1
Atrazine	ND		370	36	ug/Kg	₩	11/05/14 03:00	11/14/14 13:57	1
Benzaldehyde	ND		370	56	ug/Kg	\$	11/05/14 03:00	11/14/14 13:57	1
1,1'-Biphenyl	ND		370	33	ug/Kg	₩	11/05/14 03:00	11/14/14 13:57	1
Caprolactam	ND		1900	280	ug/Kg	₩	11/05/14 03:00	11/14/14 13:57	1
Bis(2-chloroethoxy)methane	ND		370	25	ug/Kg	₽	11/05/14 03:00	11/14/14 13:57	1
Bis(2-chloroethyl)ether	ND		75	10	ug/Kg	₽	11/05/14 03:00	11/14/14 13:57	1
Surrogate	%Recovery	Qualifier	Limits				Prepared	Analyzed	Dil Fac
Nitrobenzene-d5 (Surr)	103		25 - 104				11/05/14 03:00	11/14/14 13:57	1
Phenol-d5 (Surr)	84		25 - 105				11/05/14 03:00	11/14/14 13:57	1
2-Fluorobiphenyl	86		35 - 105				11/05/14 03:00	11/14/14 13:57	1
2,4,6-Tribromophenol (Surr)	70		35 - 124				11/05/14 03:00	11/14/14 13:57	1
2-Fluorophenol (Surr)	74		39 - 103				11/05/14 03:00	11/14/14 13:57	1
Terphenyl-d14 (Surr)	85		25 - 127				11/05/14 03:00	11/14/14 13:57	1

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
PCB-1016	ND		19	3.8	ug/Kg		11/06/14 03:45	11/08/14 02:39	1
PCB-1221	ND		19	4.7	ug/Kg	₩	11/06/14 03:45	11/08/14 02:39	1
PCB-1232	ND		19	6.5	ug/Kg	₽	11/06/14 03:45	11/08/14 02:39	1
PCB-1242	ND		19	4.7	ug/Kg	*	11/06/14 03:45	11/08/14 02:39	1
PCB-1248	ND		19	4.7	ug/Kg	₩	11/06/14 03:45	11/08/14 02:39	1
PCB-1254	570		19	4.4	ug/Kg	₩	11/06/14 03:45	11/08/14 02:39	1
PCB-1260	110		19	4.1	ug/Kg	₩	11/06/14 03:45	11/08/14 02:39	1
Surrogate	%Recovery	Qualifier	Limits				Prepared	Analyzed	Dil Fac
Tetrachloro-m-xylene (Surr)	77		45 - 135				11/06/14 03:45	11/08/14 02:39	1
DCB Decachlorobiphenyl (Surr)	83		45 - 125				11/06/14 03:45	11/08/14 02:39	1
General Chemistry									
Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Percent Moisture			0.10	0.10	%			11/05/14 15:02	1

Client Sample ID: TT-02A Lab Sample ID: 180-38441-3 Date Collected: 10/28/14 12:00 Matrix: Solid

Date Received: 11/03/14 16:10 Percent Solids: 89.6

Method: 8270D - Semivolatile								
Analyte	Result Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Acenaphthene	31 J	150	14	ug/Kg	\$	11/05/14 03:00	11/13/14 16:38	2
Acenaphthylene	150	150	17	ug/Kg	₽	11/05/14 03:00	11/13/14 16:38	2
Anthracene	240	150	14	ug/Kg	₩	11/05/14 03:00	11/13/14 16:38	2
Benzo[a]anthracene	700	150	19	ug/Kg	\$	11/05/14 03:00	11/13/14 16:38	2

TestAmerica Pittsburgh

Client: KU Resources Inc

Project/Site: Center Street Parcel, McKeesport, PA TCV

Client Sample ID: TT-02A Lab Sample ID: 180-38441-3

Date Collected: 10/28/14 12:00

Date Received: 11/03/14 16:10

Matrix: Solid
Percent Solids: 89.6

Method: 8270D - Semivolatile C	•	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fa
Benzo[a]pyrene	620		150		ug/Kg	-	11/05/14 03:00	11/13/14 16:38	
enzo[b]fluoranthene	740		150		ug/Kg	₩	11/05/14 03:00	11/13/14 16:38	
enzo[g,h,i]perylene	580		150		ug/Kg		11/05/14 03:00	11/13/14 16:38	
enzo[k]fluoranthene	390		150		ug/Kg	₽	11/05/14 03:00	11/13/14 16:38	
is(2-ethylhexyl) phthalate	ND		1500		ug/Kg	₽	11/05/14 03:00	11/13/14 16:38	
2'-oxybis[1-chloropropane]	ND		150		ug/Kg		11/05/14 03:00	11/13/14 16:38	
Bromophenyl phenyl ether	ND		730		ug/Kg	₽	11/05/14 03:00	11/13/14 16:38	
utyl benzyl phthalate	ND		730		ug/Kg	₽	11/05/14 03:00	11/13/14 16:38	
arbazole	89		150		ug/Kg	 \$	11/05/14 03:00	11/13/14 16:38	
-Chloroaniline	ND		730	59	ug/Kg	₽	11/05/14 03:00	11/13/14 16:38	
-Chloronaphthalene	ND		150		ug/Kg	₽	11/05/14 03:00	11/13/14 16:38	
-Chlorophenyl phenyl ether	ND		730		ug/Kg		11/05/14 03:00	11/13/14 16:38	
hrysene	650		150		ug/Kg	₽	11/05/14 03:00	11/13/14 16:38	
•	170		150		ug/Kg ug/Kg	₩	11/05/14 03:00	11/13/14 16:38	
ibenz(a,h)anthracene	170		730		ug/Kg ug/Kg		11/05/14 03:00	11/13/14 16:38	
ibenzofuran i-n-butyl phthalate	ND	J	730		ug/Kg ug/Kg	~ ⇔	11/05/14 03:00	11/13/14 16:38	
,3'-Dichlorobenzidine	ND		730			₩	11/05/14 03:00	11/13/14 16:38	
, 					ug/Kg				
iethyl phthalate	ND		730	81		~ ⇔	11/05/14 03:00	11/13/14 16:38	
imethyl phthalate	ND		730	81	ug/Kg	₩	11/05/14 03:00	11/13/14 16:38	
,4-Dinitrotoluene	ND		730		ug/Kg		11/05/14 03:00	11/13/14 16:38	
6-Dinitrotoluene	ND		730		ug/Kg	‡	11/05/14 03:00	11/13/14 16:38	
i-n-octyl phthalate	ND		730		ug/Kg	\$	11/05/14 03:00	11/13/14 16:38	
luoranthene	1000		150		ug/Kg	· · · · · ·	11/05/14 03:00	11/13/14 16:38	
luorene	100	J	150		ug/Kg		11/05/14 03:00	11/13/14 16:38	
exachlorobenzene	ND		150		ug/Kg	₽.	11/05/14 03:00	11/13/14 16:38	
exachlorobutadiene	ND		150		ug/Kg		11/05/14 03:00	11/13/14 16:38	
exachlorocyclopentadiene	ND		730	80	ug/Kg	₽	11/05/14 03:00	11/13/14 16:38	
exachloroethane	ND		730	53	ug/Kg	₽-	11/05/14 03:00	11/13/14 16:38	
ndeno[1,2,3-cd]pyrene	560		150	15	ug/Kg		11/05/14 03:00	11/13/14 16:38	
ophorone	ND		730	56	ug/Kg	₩	11/05/14 03:00	11/13/14 16:38	
-Methylnaphthalene	120	J	150	13	ug/Kg	₩	11/05/14 03:00	11/13/14 16:38	
aphthalene	120	J	150	13	ug/Kg	₽	11/05/14 03:00	11/13/14 16:38	
-Nitroaniline	ND		3800	330	ug/Kg	₽	11/05/14 03:00	11/13/14 16:38	
-Nitroaniline	ND		3800	300	ug/Kg	₽	11/05/14 03:00	11/13/14 16:38	
-Nitroaniline	ND		3800	300	ug/Kg	₽	11/05/14 03:00	11/13/14 16:38	
-Nitrophenol	ND		3800	270	ug/Kg	₽	11/05/14 03:00	11/13/14 16:38	
itrobenzene	ND		1500	62	ug/Kg	₩	11/05/14 03:00	11/13/14 16:38	
-Nitrosodi-n-propylamine	ND		150	17	ug/Kg	₽	11/05/14 03:00	11/13/14 16:38	
-Nitrosodiphenylamine	ND		730	69	ug/Kg	₽	11/05/14 03:00	11/13/14 16:38	
henanthrene	670		150	24	ug/Kg	₩	11/05/14 03:00	11/13/14 16:38	
yrene	840		150	15	ug/Kg	₩	11/05/14 03:00	11/13/14 16:38	
-Chloro-3-methylphenol	ND		730	68	ug/Kg	φ.	11/05/14 03:00	11/13/14 16:38	
Chlorophenol	ND		730	61	ug/Kg	₽	11/05/14 03:00	11/13/14 16:38	
Methylphenol	ND		730		ug/Kg	₽	11/05/14 03:00	11/13/14 16:38	
ethylphenol, 3 & 4	ND		730		ug/Kg	· · · · · · · · · · · · · · ·	11/05/14 03:00	11/13/14 16:38	
4-Dichlorophenol	ND		150		ug/Kg	₽	11/05/14 03:00	11/13/14 16:38	
4-Dimethylphenol	ND		730		ug/Kg	₩	11/05/14 03:00	11/13/14 16:38	
,4-Dinitrophenol	ND		3800		ug/Kg	 ₽	11/05/14 03:00	11/13/14 16:38	
,6-Dinitro-2-methylphenol	ND		3800		ug/Kg ug/Kg	₽	11/05/14 03:00	11/13/14 16:38	

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TestAmerica Job ID: 180-38441-1

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Project/Site: Center Street Parcel, McKeesport, PA TCV

Client Sample ID: TT-02A

Client: KU Resources Inc

Lab Sample ID: 180-38441-3

Matrix: Solid

Date Collected: 10/28/14 12:00 Date Received: 11/03/14 16:10 Percent Solids: 89.6

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
2-Nitrophenol	ND		730	82	ug/Kg	<u></u>	11/05/14 03:00	11/13/14 16:38	2
Pentachlorophenol	ND		730	66	ug/Kg	₽	11/05/14 03:00	11/13/14 16:38	2
Phenol	ND		150	17	ug/Kg	₽	11/05/14 03:00	11/13/14 16:38	2
2,4,5-Trichlorophenol	ND		730	79	ug/Kg	₽	11/05/14 03:00	11/13/14 16:38	2
2,4,6-Trichlorophenol	ND		730	110	ug/Kg	₽	11/05/14 03:00	11/13/14 16:38	2
Acetophenone	ND		730	61	ug/Kg	₽	11/05/14 03:00	11/13/14 16:38	2
Atrazine	ND		730	72	ug/Kg	₽	11/05/14 03:00	11/13/14 16:38	2
Benzaldehyde	ND		730	110	ug/Kg	₽	11/05/14 03:00	11/13/14 16:38	2
1,1'-Biphenyl	ND		730	66	ug/Kg	₽	11/05/14 03:00	11/13/14 16:38	2
Caprolactam	ND		3800	560	ug/Kg	₽	11/05/14 03:00	11/13/14 16:38	2
Bis(2-chloroethoxy)methane	ND		730	49	ug/Kg	₽	11/05/14 03:00	11/13/14 16:38	2
Bis(2-chloroethyl)ether	ND		150	20	ug/Kg	₽	11/05/14 03:00	11/13/14 16:38	2
Surrogate	%Recovery	Qualifier	Limits				Prepared	Analyzed	Dil Fac
Nitrobenzene-d5 (Surr)	74		25 - 104				11/05/14 03:00	11/13/14 16:38	2
Phenol-d5 (Surr)	61		25 - 105				11/05/14 03:00	11/13/14 16:38	2
2-Fluorobiphenyl	69		35 - 105				11/05/14 03:00	11/13/14 16:38	2
2,4,6-Tribromophenol (Surr)	51		35 - 124				11/05/14 03:00	11/13/14 16:38	2
2-Fluorophenol (Surr)	55		39 - 103				11/05/14 03:00	11/13/14 16:38	2
Terphenyl-d14 (Surr)	59		25 - 127				11/05/14 03:00	11/13/14 16:38	2

	-		-0						_
Method: 8082A - Polychlorina	ted Biphenvis (P	CBs) by Ga	s Chromatogran	ohv					
Analyte		Qualifier	RL	_	Unit	D	Prepared	Analyzed	Dil Fac
PCB-1016	ND		18	3.8	ug/Kg	<u> </u>	11/06/14 03:45	11/08/14 03:10	1
PCB-1221	ND		18	4.6	ug/Kg	₩	11/06/14 03:45	11/08/14 03:10	1
PCB-1232	ND		18	6.4	ug/Kg	₩	11/06/14 03:45	11/08/14 03:10	1
PCB-1242	ND		18	4.7	ug/Kg	₩.	11/06/14 03:45	11/08/14 03:10	1
PCB-1248	ND		18	4.6	ug/Kg	₩	11/06/14 03:45	11/08/14 03:10	1
PCB-1254	91		18	4.4	ug/Kg	₩	11/06/14 03:45	11/08/14 03:10	1
PCB-1260	68		18	4.1	ug/Kg	\$	11/06/14 03:45	11/08/14 03:10	1
Surrogate	%Recovery	Qualifier	Limits				Prepared	Analyzed	Dil Fac
Tetrachloro-m-xylene (Surr)	74		45 - 135				11/06/14 03:45	11/08/14 03:10	1
DCB Decachlorobiphenyl (Surr)	81		45 - 125				11/06/14 03:45	11/08/14 03:10	1
- General Chemistry									
Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Percent Moisture	10		0.10	0.10	%			11/05/14 15:02	1

Client Sample ID: TT-02B Lab Sample ID: 180-38441-4 Date Collected: 10/28/14 12:15 Matrix: Solid Date Received: 11/03/14 16:10 Percent Solids: 87.6

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Acenaphthene	32	J	150	15	ug/Kg	\$	11/05/14 03:00	11/13/14 17:07	2
Acenaphthylene	230		150	17	ug/Kg	₽	11/05/14 03:00	11/13/14 17:07	2
Anthracene	220		150	15	ug/Kg	₩	11/05/14 03:00	11/13/14 17:07	2
Benzo[a]anthracene	800		150	19	ug/Kg	₽	11/05/14 03:00	11/13/14 17:07	2
Benzo[a]pyrene	800		150	15	ug/Kg	₽	11/05/14 03:00	11/13/14 17:07	2
Benzo[b]fluoranthene	1100		150	24	ug/Kg	₩	11/05/14 03:00	11/13/14 17:07	2

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Client: KU Resources Inc TestAmerica Job ID: 180-38441-1

Project/Site: Center Street Parcel, McKeesport, PA TCV

Client Sample ID: TT-02B

Lab Sample ID: 180-38441-4 Date Collected: 10/28/14 12:15 **Matrix: Solid** Date Received: 11/03/14 16:10 Percent Solids: 87.6

Method: 8270D - Semivolatile Organic Compounds (GC/MS) (Continued) Result Qualifier MDL Unit D Dil Fac Analyte Prepared Analyzed 150 11/05/14 03:00 11/13/14 17:07 Benzo[g,h,i]perylene 780 15 ug/Kg φ 150 2 11/05/14 03:00 11/13/14 17:07 Benzo[k]fluoranthene 390 31 ug/Kg ä Bis(2-ethylhexyl) phthalate ND 1500 120 ug/Kg 11/05/14 03:00 11/13/14 17:07 2 φ ND 150 11/05/14 03:00 11/13/14 17:07 2 2,2'-oxybis[1-chloropropane] 16 ug/Kg 2 4-Bromophenyl phenyl ether ND 750 66 ug/Kg 11/05/14 03:00 11/13/14 17:07 Butyl benzyl phthalate ₽ ND 750 11/05/14 03:00 2 100 ug/Kg 11/13/14 17:07 φ Carbazole 150 14 ug/Kg 11/05/14 03:00 11/13/14 17:07 2 77 ND 750 11/05/14 03:00 11/13/14 17:07 2 4-Chloroaniline 61 ug/Kg ₽ 2 2-Chloronaphthalene ND 150 16 ug/Kg 11/05/14 03:00 11/13/14 17:07 φ 4-Chlorophenyl phenyl ether ND 750 84 ug/Kg 11/05/14 03:00 11/13/14 17:07 2 # 2 860 150 18 ug/Kg 11/05/14 03:00 11/13/14 17:07 Chrysene ₩ 11/05/14 03:00 2 130 150 17 ug/Kg 11/13/14 17:07 Dibenz(a,h)anthracene ġ 2 750 74 Dibenzofuran 110 ug/Kg 11/05/14 03:00 11/13/14 17:07 Di-n-butyl phthalate ND 750 95 ug/Kg 11/05/14 03:00 11/13/14 17:07 2 ġ 2 3,3'-Dichlorobenzidine ND 750 80 11/05/14 03:00 ug/Kg 11/13/14 17:07 à Diethyl phthalate ND 750 11/05/14 03:00 11/13/14 17:07 2 ug/Kg ND 11/05/14 03:00 2 Dimethyl phthalate 750 82 ug/Kg 11/13/14 17:07 ġ 2,4-Dinitrotoluene ND 750 11/05/14 03:00 11/13/14 17:07 2 ug/Kg 2,6-Dinitrotoluene ND 750 ψ 11/05/14 03:00 2 78 ug/Kg 11/13/14 17:07 ₩ Di-n-octyl phthalate ND 750 80 ug/Kg 11/05/14 03:00 11/13/14 17:07 2 ₽ 1300 150 16 ua/Ka 11/05/14 03:00 11/13/14 17:07 2 **Fluoranthene** ψ 2 150 45 20 ug/Kg 11/05/14 03:00 11/13/14 17:07 **Fluorene** ₩ ND 150 11/05/14 03:00 11/13/14 17:07 2 Hexachlorobenzene 16 ua/Ka ġ Hexachlorobutadiene ND 150 17 ug/Kg 11/05/14 03:00 11/13/14 17:07 2 Hexachlorocyclopentadiene ND 750 82 ug/Kg 11/05/14 03:00 11/13/14 17:07 2 ND 2 Hexachloroethane 750 11/05/14 03:00 11/13/14 17:07 54 ug/Kg 150 11/05/14 03:00 2 Indeno[1,2,3-cd]pyrene 710 16 ug/Kg 11/13/14 17:07 ψ 2 Isophorone ND 750 11/05/14 03:00 11/13/14 17:07 57 ug/Kg ₩ 150 11/05/14 03:00 11/13/14 17:07 2 2-Methylnaphthalene 160 14 ug/Kg 150 11/05/14 03:00 2 13 ug/Kg 11/13/14 17:07 Naphthalene 120 2-Nitroaniline ND 3900 340 ug/Kg 11/05/14 03:00 11/13/14 17:07 2 ₽ 3-Nitroaniline ND 3900 310 ug/Kg 11/05/14 03:00 11/13/14 17:07 2 ₩ 4-Nitroaniline ND 3900 310 ug/Kg 11/05/14 03:00 11/13/14 17:07 2 ₽ 4-Nitrophenol ND 3900 280 11/05/14 03:00 11/13/14 17:07 2 ug/Kg \$ Nitrobenzene ND 1500 ug/Kg 11/05/14 03:00 11/13/14 17:07 2 ₩ N-Nitrosodi-n-propylamine ND 150 ug/Kg 11/05/14 03:00 11/13/14 17:07 2 18 φ 2 N-Nitrosodiphenylamine ND 750 11/05/14 03:00 70 ug/Kg 11/13/14 17:07 ġ **Phenanthrene** 650 150 24 ug/Kg 11/05/14 03:00 11/13/14 17:07 2 2 150 ug/Kg 11/05/14 03:00 11/13/14 17:07 Pyrene 1100 15 750 à 11/05/14 03:00 2 4-Chloro-3-methylphenol ND 70 ug/Kg 11/13/14 17:07 2 ND ug/Kg 2-Chlorophenol 750 62 11/05/14 03:00 11/13/14 17:07 ₩ 2-Methylphenol ND 750 53 ug/Kg 11/05/14 03:00 11/13/14 17:07 2 ND 750 11/05/14 03:00 2 Methylphenol, 3 & 4 74 11/13/14 17:07 ug/Kg ġ 2,4-Dichlorophenol ND 150 11/05/14 03:00 11/13/14 17:07 2 15 ug/Kg ф 750 ug/Kg 2 2,4-Dimethylphenol ND 120 11/05/14 03:00 11/13/14 17:07 φ 2,4-Dinitrophenol ND 3900 900 ug/Kg 11/05/14 03:00 11/13/14 17:07 2 4,6-Dinitro-2-methylphenol ND 3900 300 ug/Kg ₽ 11/05/14 03:00 11/13/14 17:07 2 # 2 2-Nitrophenol ND 750 83 ug/Kg 11/05/14 03:00 11/13/14 17:07 Pentachlorophenol 750 ND 68 ug/Kg 11/05/14 03:00 11/13/14 17:07

TestAmerica Pittsburgh

11/17/2014

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Client: KU Resources Inc

Date Collected: 10/28/14 12:15

Date Received: 11/03/14 16:10

DCB Decachlorobiphenyl (Surr)

Date Received: 11/03/14 16:10

Project/Site: Center Street Parcel, McKeesport, PA TCV

Client Sample ID: TT-02B

Lab Sample ID: 180-38441-4

TestAmerica Job ID: 180-38441-1

Matrix: Solid

Percent Solids: 87.6

Method: 8270D - Semivolatile	•	•				_			5".5
Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Phenol	ND		150	18	ug/Kg	₩	11/05/14 03:00	11/13/14 17:07	2
2,4,5-Trichlorophenol	ND		750	81	ug/Kg	₽	11/05/14 03:00	11/13/14 17:07	2
2,4,6-Trichlorophenol	ND		750	110	ug/Kg	₩	11/05/14 03:00	11/13/14 17:07	2
Acetophenone	ND		750	62	ug/Kg	≎	11/05/14 03:00	11/13/14 17:07	2
Atrazine	ND		750	74	ug/Kg	☼	11/05/14 03:00	11/13/14 17:07	2
Benzaldehyde	ND		750	110	ug/Kg	₽	11/05/14 03:00	11/13/14 17:07	2
1,1'-Biphenyl	ND		750	68	ug/Kg	☼	11/05/14 03:00	11/13/14 17:07	2
Caprolactam	ND		3900	570	ug/Kg	≎	11/05/14 03:00	11/13/14 17:07	2
Bis(2-chloroethoxy)methane	ND		750	50	ug/Kg	₽	11/05/14 03:00	11/13/14 17:07	2
Bis(2-chloroethyl)ether	ND		150	20	ug/Kg	₽	11/05/14 03:00	11/13/14 17:07	2
Surrogate	%Recovery	Qualifier	Limits				Prepared	Analyzed	Dil Fac
Nitrobenzene-d5 (Surr)	82		25 - 104				11/05/14 03:00	11/13/14 17:07	2
Phenol-d5 (Surr)	64		25 - 105				11/05/14 03:00	11/13/14 17:07	2
2-Fluorobiphenyl	74		35 - 105				11/05/14 03:00	11/13/14 17:07	2
2,4,6-Tribromophenol (Surr)	62		35 - 124				11/05/14 03:00	11/13/14 17:07	2
2-Fluorophenol (Surr)	51		39 - 103				11/05/14 03:00	11/13/14 17:07	2
Terphenyl-d14 (Surr)	69		25 _ 127				11/05/14 03:00	11/13/14 17:07	2

Analyte	Result Qualif	ier RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
PCB-1016	ND	19	3.9	ug/Kg	\	11/06/14 03:45	11/08/14 03:41	1
PCB-1221	ND	19	4.7	ug/Kg	₽	11/06/14 03:45	11/08/14 03:41	1
PCB-1232	ND	19	6.5	ug/Kg	₽	11/06/14 03:45	11/08/14 03:41	1
PCB-1242	ND	19	4.8	ug/Kg	₽	11/06/14 03:45	11/08/14 03:41	1
PCB-1248	ND	19	4.7	ug/Kg	₽	11/06/14 03:45	11/08/14 03:41	1
PCB-1254	680	19	4.5	ug/Kg	₽	11/06/14 03:45	11/08/14 03:41	1
PCB-1260	260	19	4.1	ug/Kg	*	11/06/14 03:45	11/08/14 03:41	1
Surrogate	%Recovery Quality	fier Limits				Prepared	Analyzed	Dil Fac
Tetrachloro-m-xylene (Surr)		45 - 135				11/06/14 03:45	11/08/14 03:41	

_									
General Chemistry									
Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Percent Moisture	12		0.10	0.10	%			11/05/14 15:02	1

45 - 125

Client Sample ID: TT-03A

Date Collected: 10/28/14 10:45

Matrix: Solid

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Acenaphthene	30	J	77	7.4	ug/Kg	*	11/05/14 03:00	11/13/14 18:34	1
Acenaphthylene	180		77	8.8	ug/Kg	₽	11/05/14 03:00	11/13/14 18:34	1
Anthracene	230		77	7.5	ug/Kg	₽	11/05/14 03:00	11/13/14 18:34	1
Benzo[a]anthracene	720		77	9.6	ug/Kg	₽	11/05/14 03:00	11/13/14 18:34	1
Benzo[a]pyrene	670		77	7.7	ug/Kg	₽	11/05/14 03:00	11/13/14 18:34	1
Benzo[b]fluoranthene	970		77	12	ug/Kg	₽	11/05/14 03:00	11/13/14 18:34	1
Benzo[g,h,i]perylene	660		77	7.6	ug/Kg	₽	11/05/14 03:00	11/13/14 18:34	1
Benzo[k]fluoranthene	350		77	15	ug/Kg	₩	11/05/14 03:00	11/13/14 18:34	1

TestAmerica Pittsburgh

Percent Solids: 87.2

Client: KU Resources Inc

Project/Site: Center Street Parcel, McKeesport, PA TCV

Client Sample ID: TT-03A Lab Sample ID

Date Collected: 10/28/14 10:45
Date Received: 11/03/14 16:10

Lab Sample ID: 180-38441-5 Matrix: Solid

TestAmerica Job ID: 180-38441-1

Percent Solids: 87.2

Analyte	Result Qualifier	RL		Unit	D	Prepared	Analyzed	Dil Fa
Bis(2-ethylhexyl) phthalate	ND	770	62	ug/Kg	<u></u> .	11/05/14 03:00	11/13/14 18:34	
2,2'-oxybis[1-chloropropane]	ND	77	8.3		*	11/05/14 03:00	11/13/14 18:34	
4-Bromophenyl phenyl ether	ND	380	33	ug/Kg	₩	11/05/14 03:00	11/13/14 18:34	
Butyl benzyl phthalate	ND	380	52			11/05/14 03:00	11/13/14 18:34	
Carbazole	63 J	77	7.1	ug/Kg	₽	11/05/14 03:00	11/13/14 18:34	•
4-Chloroaniline	ND	380	31	ug/Kg	₽	11/05/14 03:00	11/13/14 18:34	•
2-Chloronaphthalene	ND	77	8.0	ug/Kg		11/05/14 03:00	11/13/14 18:34	
4-Chlorophenyl phenyl ether	ND	380	43	ug/Kg	₽	11/05/14 03:00	11/13/14 18:34	•
Chrysene	770	77	9.1	ug/Kg	₽	11/05/14 03:00	11/13/14 18:34	•
Dibenz(a,h)anthracene	190	77	8.5	ug/Kg	₽	11/05/14 03:00	11/13/14 18:34	•
Dibenzofuran	110 J	380	38	ug/Kg	*	11/05/14 03:00	11/13/14 18:34	
Di-n-butyl phthalate	ND	380	48	ug/Kg	₽	11/05/14 03:00	11/13/14 18:34	
3,3'-Dichlorobenzidine	ND	380	40	ug/Kg	₽	11/05/14 03:00	11/13/14 18:34	
Diethyl phthalate	ND	380	42	ug/Kg		11/05/14 03:00	11/13/14 18:34	
Dimethyl phthalate	ND	380	42	ug/Kg	₩	11/05/14 03:00	11/13/14 18:34	
2,4-Dinitrotoluene	ND	380	31	ug/Kg	₽	11/05/14 03:00	11/13/14 18:34	
2,6-Dinitrotoluene	ND	380	39	ug/Kg	φ.	11/05/14 03:00	11/13/14 18:34	
Di-n-octyl phthalate	ND	380	40	ug/Kg	₽	11/05/14 03:00	11/13/14 18:34	
Fluoranthene	1300	77	8.2	ug/Kg	₽	11/05/14 03:00	11/13/14 18:34	
Fluorene	43 J	77		ug/Kg		11/05/14 03:00	11/13/14 18:34	· · · · · · .
Hexachlorobenzene	ND	77		ug/Kg	₽	11/05/14 03:00	11/13/14 18:34	
Hexachlorobutadiene	ND	77		ug/Kg	₽	11/05/14 03:00	11/13/14 18:34	
Hexachlorocyclopentadiene	ND	380		ug/Kg		11/05/14 03:00	11/13/14 18:34	
Hexachloroethane	ND	380	28	ug/Kg	₽	11/05/14 03:00	11/13/14 18:34	
Indeno[1,2,3-cd]pyrene	610	77	7.9	ug/Kg	₽	11/05/14 03:00	11/13/14 18:34	
Isophorone	ND	380	29	ug/Kg		11/05/14 03:00	11/13/14 18:34	
·	170	77	6.9	ug/Kg	₽	11/05/14 03:00	11/13/14 18:34	
2-Methylnaphthalene	220	77	6.6	ug/Kg	₩	11/05/14 03:00	11/13/14 18:34	
Naphthalene 2-Nitroaniline	ND	2000	170			11/05/14 03:00	11/13/14 18:34	
3-Nitroaniline	ND ND	2000		ug/Kg ug/Kg			11/13/14 18:34	
			160		~ ⇔	11/05/14 03:00		
4-Nitroaniline	ND ND	2000	150	ug/Kg	.	11/05/14 03:00	11/13/14 18:34	
4-Nitrophenol	ND	2000	140			11/05/14 03:00	11/13/14 18:34	•
Nitrobenzene	ND	770			\$	11/05/14 03:00	11/13/14 18:34	•
N-Nitrosodi-n-propylamine	ND	77		ug/Kg	<u></u> .	11/05/14 03:00	11/13/14 18:34	
N-Nitrosodiphenylamine	ND	380		ug/Kg	₩.	11/05/14 03:00	11/13/14 18:34	•
Phenanthrene	750	77		ug/Kg	₩	11/05/14 03:00	11/13/14 18:34	•
Pyrene	950	77		ug/Kg		11/05/14 03:00	11/13/14 18:34	
4-Chloro-3-methylphenol	ND	380		ug/Kg	₽.	11/05/14 03:00	11/13/14 18:34	•
2-Chlorophenol	ND	380		ug/Kg	₩.	11/05/14 03:00	11/13/14 18:34	•
2-Methylphenol	ND	380		ug/Kg		11/05/14 03:00	11/13/14 18:34	
Methylphenol, 3 & 4	ND	380	37	ug/Kg	₽-	11/05/14 03:00	11/13/14 18:34	•
2,4-Dichlorophenol	ND	77	7.7	ug/Kg	₽	11/05/14 03:00	11/13/14 18:34	•
2,4-Dimethylphenol	ND	380	60	ug/Kg		11/05/14 03:00	11/13/14 18:34	
2,4-Dinitrophenol	ND	2000	460	ug/Kg	₩	11/05/14 03:00	11/13/14 18:34	
4,6-Dinitro-2-methylphenol	ND	2000	150	ug/Kg	₩	11/05/14 03:00	11/13/14 18:34	
2-Nitrophenol	ND	380	42	ug/Kg	☼	11/05/14 03:00	11/13/14 18:34	
Pentachlorophenol	ND	380	34	ug/Kg	\$	11/05/14 03:00	11/13/14 18:34	
Phenol	ND	77	9.0	ug/Kg	₽	11/05/14 03:00	11/13/14 18:34	
2,4,5-Trichlorophenol	ND	380	41	ug/Kg	₽	11/05/14 03:00	11/13/14 18:34	

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11/17/2014

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11

12

Project/Site: Center Street Parcel, McKeesport, PA TCV

Client: KU Resources Inc

Client Sample ID: TT-03A

Lab Sample ID: 180-38441-5 Date Collected: 10/28/14 10:45 Matrix: Solid Date Received: 11/03/14 16:10 Percent Solids: 87.2

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
2,4,6-Trichlorophenol	ND		380	57	ug/Kg	₩	11/05/14 03:00	11/13/14 18:34	1
Acetophenone	ND		380	31	ug/Kg	\$	11/05/14 03:00	11/13/14 18:34	1
Atrazine	ND		380	37	ug/Kg	₽	11/05/14 03:00	11/13/14 18:34	1
Benzaldehyde	ND		380	57	ug/Kg	\$	11/05/14 03:00	11/13/14 18:34	1
1,1'-Biphenyl	ND		380	34	ug/Kg	₽	11/05/14 03:00	11/13/14 18:34	1
Caprolactam	ND		2000	290	ug/Kg	₽	11/05/14 03:00	11/13/14 18:34	1
Bis(2-chloroethoxy)methane	ND		380	25	ug/Kg	φ.	11/05/14 03:00	11/13/14 18:34	1
Bis(2-chloroethyl)ether	ND		77	10	ug/Kg	₽	11/05/14 03:00	11/13/14 18:34	1
Surrogate	%Recovery	Qualifier	Limits				Prepared	Analyzed	Dil Fac
Nitrobenzene-d5 (Surr)	85		25 - 104				11/05/14 03:00	11/13/14 18:34	1
Phenol-d5 (Surr)	72		25 - 105				11/05/14 03:00	11/13/14 18:34	1
2-Fluorobiphenyl	74		35 - 105				11/05/14 03:00	11/13/14 18:34	1
2,4,6-Tribromophenol (Surr)	57		35 - 124				11/05/14 03:00	11/13/14 18:34	1
2-Fluorophenol (Surr)	61		39 - 103				11/05/14 03:00	11/13/14 18:34	1
Terphenyl-d14 (Surr)	65		25 - 127				11/05/14 03:00	11/13/14 18:34	1

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
PCB-1016	ND		19	3.9	ug/Kg	\$	11/06/14 03:45	11/08/14 05:15	1
PCB-1221	ND		19	4.8	ug/Kg	₽	11/06/14 03:45	11/08/14 05:15	1
PCB-1232	ND		19	6.6	ug/Kg	₽	11/06/14 03:45	11/08/14 05:15	1
PCB-1242	ND		19	4.8	ug/Kg	₽	11/06/14 03:45	11/08/14 05:15	1
PCB-1248	ND		19	4.8	ug/Kg	₽	11/06/14 03:45	11/08/14 05:15	1
PCB-1254	240		19	4.6	ug/Kg	₽	11/06/14 03:45	11/08/14 05:15	1
PCB-1260	120		19	4.2	ug/Kg		11/06/14 03:45	11/08/14 05:15	1

Surrogate	%Recovery	Qualifier	Limits	Prepared	Analyzed	Dil Fac
Tetrachloro-m-xylene (Surr)	72		45 - 135	11/06/14 03:45	11/08/14 05:15	1
DCB Decachlorobiphenyl (Surr)	81		45 - 125	11/06/14 03:45	11/08/14 05:15	1

General Chemistry							
Analyte	Result Qualifier	RL	MDL Unit	D	Prepared	Analyzed	Dil Fac
Percent Moisture	13	0.10	0.10 %			11/05/14 15:02	1

Client Sample ID: TT-03B Lab Sample ID: 180-38441-6 Date Collected: 10/28/14 11:00 Matrix: Solid Date Received: 11/03/14 16:10 Percent Solids: 87.5

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Acenaphthene	35	J	77	7.3	ug/Kg	*	11/05/14 03:00	11/13/14 19:03	1
Acenaphthylene	260		77	8.7	ug/Kg	₩	11/05/14 03:00	11/13/14 19:03	1
Anthracene	310		77	7.5	ug/Kg	₩	11/05/14 03:00	11/13/14 19:03	1
Benzo[a]anthracene	1400		77	9.6	ug/Kg	\$	11/05/14 03:00	11/13/14 19:03	1
Benzo[a]pyrene	1400		77	7.6	ug/Kg	₩	11/05/14 03:00	11/13/14 19:03	1
Benzo[b]fluoranthene	2000		77	12	ug/Kg	₽	11/05/14 03:00	11/13/14 19:03	1
Benzo[g,h,i]perylene	1700		77	7.6	ug/Kg	\$	11/05/14 03:00	11/13/14 19:03	1
Benzo[k]fluoranthene	620		77	15	ug/Kg	₩	11/05/14 03:00	11/13/14 19:03	1
Bis(2-ethylhexyl) phthalate	ND		770	62	ug/Kg	₩	11/05/14 03:00	11/13/14 19:03	1
2,2'-oxybis[1-chloropropane]	ND		77	8.2	ug/Kg	₩	11/05/14 03:00	11/13/14 19:03	1

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Client: KU Resources Inc

Project/Site: Center Street Parcel, McKeesport, PA TCV

Client Sample ID: TT-03B Lab Sample ID: 180-38441-6

Date Collected: 10/28/14 11:00 Date Received: 11/03/14 16:10

TestAmerica Job ID: 180-38441-1

Matrix: Solid

Percent Solids: 87.5

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fa
4-Bromophenyl phenyl ether	ND		380	33	ug/Kg	-	11/05/14 03:00	11/13/14 19:03	
Butyl benzyl phthalate	ND		380	52	ug/Kg	₽	11/05/14 03:00	11/13/14 19:03	
Carbazole	69	J	77	7.0	ug/Kg		11/05/14 03:00	11/13/14 19:03	
4-Chloroaniline	ND		380	31	ug/Kg	₩	11/05/14 03:00	11/13/14 19:03	
2-Chloronaphthalene	ND		77	8.0	ug/Kg	₩	11/05/14 03:00	11/13/14 19:03	
4-Chlorophenyl phenyl ether	ND		380	42	ug/Kg		11/05/14 03:00	11/13/14 19:03	
Chrysene	1500		77	9.1	ug/Kg	₩	11/05/14 03:00	11/13/14 19:03	
Dibenz(a,h)anthracene	430		77	8.5	ug/Kg	₽	11/05/14 03:00	11/13/14 19:03	
Dibenzofuran	83	J	380	38	ug/Kg		11/05/14 03:00	11/13/14 19:03	
Di-n-butyl phthalate	ND		380	48	ug/Kg	₽	11/05/14 03:00	11/13/14 19:03	
3,3'-Dichlorobenzidine	ND		380	40	ug/Kg	₽	11/05/14 03:00	11/13/14 19:03	
Diethyl phthalate	70		380	42	ug/Kg		11/05/14 03:00	11/13/14 19:03	
Dimethyl phthalate	ND		380		ug/Kg	₽	11/05/14 03:00	11/13/14 19:03	
2,4-Dinitrotoluene	ND		380	31	ug/Kg	₽	11/05/14 03:00	11/13/14 19:03	
2,6-Dinitrotoluene	ND		380		ug/Kg	ф	11/05/14 03:00	11/13/14 19:03	
Di-n-octyl phthalate	ND		380	40	ug/Kg	₽	11/05/14 03:00	11/13/14 19:03	
Fluoranthene	1800		77		ug/Kg	₽	11/05/14 03:00	11/13/14 19:03	
Fluorene	49		77		ug/Kg		11/05/14 03:00	11/13/14 19:03	
Hexachlorobenzene	ND		77	8.1	ug/Kg	₩	11/05/14 03:00	11/13/14 19:03	
Hexachlorobutadiene	ND		77	8.5	ug/Kg	₩	11/05/14 03:00	11/13/14 19:03	
Hexachlorocyclopentadiene	ND		380	41	ug/Kg		11/05/14 03:00	11/13/14 19:03	
Hexachloroethane	ND		380	27	ug/Kg	₩	11/05/14 03:00	11/13/14 19:03	
Indeno[1,2,3-cd]pyrene	1400		77	7.9	ug/Kg	₩	11/05/14 03:00	11/13/14 19:03	
Isophorone	ND		380	29	ug/Kg ug/Kg		11/05/14 03:00	11/13/14 19:03	
2-Methylnaphthalene	140		77	6.9	ug/Kg ug/Kg		11/05/14 03:00	11/13/14 19:03	
			77		ug/Kg ug/Kg		11/05/14 03:00	11/13/14 19:03	
Naphthalene 2-Nitroaniline	160 ND		1900	170	ug/Kg ug/Kg		11/05/14 03:00	11/13/14 19:03	
3-Nitroaniline	ND ND		1900		ug/Kg ug/Kg		11/05/14 03:00	11/13/14 19:03	
4-Nitroaniline	ND ND		1900	160	ug/Kg ug/Kg		11/05/14 03:00	11/13/14 19:03	
	ND		1900	150	ug/Kg ug/Kg		11/05/14 03:00	11/13/14 19:03	
4-Nitrophenol	ND ND			140		₽			
Nitrobenzene			770		ug/Kg	₩	11/05/14 03:00	11/13/14 19:03	
N-Nitrosodi-n-propylamine	ND		77	8.9	ug/Kg		11/05/14 03:00	11/13/14 19:03	
N-Nitrosodiphenylamine	ND		380		ug/Kg	₽	11/05/14 03:00	11/13/14 19:03	
Phenanthrene -	650		77	12	ug/Kg	‡	11/05/14 03:00	11/13/14 19:03	
Pyrene	1900		77		ug/Kg	<u></u>	11/05/14 03:00	11/13/14 19:03	
4-Chloro-3-methylphenol	ND		380	35	ug/Kg	1,1	11/05/14 03:00	11/13/14 19:03	
2-Chlorophenol	ND		380	31	ug/Kg	*	11/05/14 03:00	11/13/14 19:03	
2-Methylphenol	ND		380		ug/Kg		11/05/14 03:00	11/13/14 19:03	
Methylphenol, 3 & 4	ND		380		ug/Kg	₩	11/05/14 03:00	11/13/14 19:03	
2,4-Dichlorophenol	ND		77		ug/Kg	₩	11/05/14 03:00	11/13/14 19:03	
2,4-Dimethylphenol	ND		380	60	ug/Kg	<u></u>	11/05/14 03:00	11/13/14 19:03	
2,4-Dinitrophenol	ND		1900		ug/Kg	*	11/05/14 03:00	11/13/14 19:03	
4,6-Dinitro-2-methylphenol	ND		1900		ug/Kg	₽	11/05/14 03:00	11/13/14 19:03	
2-Nitrophenol	ND		380	42	ug/Kg		11/05/14 03:00	11/13/14 19:03	
Pentachlorophenol	ND		380	34	ug/Kg	₽	11/05/14 03:00	11/13/14 19:03	
Phenol	ND		77	9.0	ug/Kg	₽	11/05/14 03:00	11/13/14 19:03	
2,4,5-Trichlorophenol	ND		380	41	ug/Kg	₩	11/05/14 03:00	11/13/14 19:03	
2,4,6-Trichlorophenol	ND		380	57	ug/Kg	\$	11/05/14 03:00	11/13/14 19:03	
Acetophenone	ND		380	31	ug/Kg	₩	11/05/14 03:00	11/13/14 19:03	

TestAmerica Pittsburgh

Project/Site: Center Street Parcel, McKeesport, PA TCV

Client Sample ID: TT-03B

Client: KU Resources Inc

Analyte

Percent Moisture

Date Collected: 10/28/14 11:00 Date Received: 11/03/14 16:10

Lab Sample ID: 180-38441-6

Matrix: Solid

Percent Solids: 87.5

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Atrazine	ND		380	37	ug/Kg	₩	11/05/14 03:00	11/13/14 19:03	1
Benzaldehyde	ND		380	57	ug/Kg	\$	11/05/14 03:00	11/13/14 19:03	1
1,1'-Biphenyl	ND		380	34	ug/Kg	₽	11/05/14 03:00	11/13/14 19:03	1
Caprolactam	ND		1900	290	ug/Kg	₩	11/05/14 03:00	11/13/14 19:03	1
Bis(2-chloroethoxy)methane	ND		380	25	ug/Kg	₽	11/05/14 03:00	11/13/14 19:03	1
Bis(2-chloroethyl)ether	ND		77	10	ug/Kg	₽	11/05/14 03:00	11/13/14 19:03	1
Surrogate	%Recovery	Qualifier	Limits				Prepared	Analyzed	Dil Fac
Nitrobenzene-d5 (Surr)	82		25 - 104				11/05/14 03:00	11/13/14 19:03	1
Phenol-d5 (Surr)	65		25 - 105				11/05/14 03:00	11/13/14 19:03	1
2-Fluorobiphenyl	67		35 - 105				11/05/14 03:00	11/13/14 19:03	1
2,4,6-Tribromophenol (Surr)	56		35 - 124				11/05/14 03:00	11/13/14 19:03	1
2-Fluorophenol (Surr)	56		39 - 103				11/05/14 03:00	11/13/14 19:03	1
Terphenyl-d14 (Surr)	63		25 - 127				11/05/14 03:00	11/13/14 19:03	1
Method: 8082A - Polychlorinat	ed Biphenyls (PC	CBs) by Gas	Chromatograp	hy					
Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
PCB-1016	ND		19	3.9	ug/Kg	<u> </u>	11/06/14 03:45	11/08/14 05:47	1
PCB-1221	ND		19	4.8	ug/Kg	₽	11/06/14 03:45	11/08/14 05:47	1
PCB-1232	ND		19	6.6	ug/Kg	₽	11/06/14 03:45	11/08/14 05:47	1
PCB-1242	ND		19	4.8	ug/Kg	₽	11/06/14 03:45	11/08/14 05:47	1
PCB-1248	ND		19	4.8	ug/Kg	₽	11/06/14 03:45	11/08/14 05:47	1
PCB-1254	85		19	4.5	ug/Kg	₩	11/06/14 03:45	11/08/14 05:47	1
PCB-1260	99		19	4.2	ug/Kg	₽	11/06/14 03:45	11/08/14 05:47	1
Surrogate	%Recovery	Qualifier	Limits				Prepared	Analyzed	Dil Fac
Tetrachloro-m-xylene (Surr)	81		45 - 135				11/06/14 03:45	11/08/14 05:47	1
DCB Decachlorobiphenyl (Surr)	92		45 - 125				11/06/14 03:45	11/08/14 05:47	1

Client Sample ID: TT-04A Lab Sample ID: 180-38441-7

RL

0.10

MDL Unit

0.10 %

D

Prepared

Result Qualifier

13

Date Collected: 10/28/14 10:00 **Matrix: Solid** Date Received: 11/03/14 16:10 Percent Solids: 90.6

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Acenaphthene	43	J	73	7.0	ug/Kg	₩	11/05/14 03:00	11/13/14 19:32	1
Acenaphthylene	110		73	8.4	ug/Kg	₽	11/05/14 03:00	11/13/14 19:32	1
Anthracene	230		73	7.2	ug/Kg	₽	11/05/14 03:00	11/13/14 19:32	1
Benzo[a]anthracene	950		73	9.2	ug/Kg	₽	11/05/14 03:00	11/13/14 19:32	1
Benzo[a]pyrene	1100		73	7.3	ug/Kg	₽	11/05/14 03:00	11/13/14 19:32	1
Benzo[b]fluoranthene	1300		73	11	ug/Kg	₽	11/05/14 03:00	11/13/14 19:32	1
Benzo[g,h,i]perylene	1100		73	7.3	ug/Kg	₽	11/05/14 03:00	11/13/14 19:32	1
Benzo[k]fluoranthene	550		73	15	ug/Kg	₽	11/05/14 03:00	11/13/14 19:32	1
Bis(2-ethylhexyl) phthalate	160	J	730	59	ug/Kg	₽	11/05/14 03:00	11/13/14 19:32	1
2,2'-oxybis[1-chloropropane]	ND		73	7.9	ug/Kg	\$	11/05/14 03:00	11/13/14 19:32	1
4-Bromophenyl phenyl ether	ND		360	32	ug/Kg	₽	11/05/14 03:00	11/13/14 19:32	1
Butyl benzyl phthalate	ND		360	50	ug/Kg	₩	11/05/14 03:00	11/13/14 19:32	1

TestAmerica Pittsburgh

Dil Fac

Analyzed

11/05/14 15:02

Client: KU Resources Inc

Project/Site: Center Street Parcel, McKeesport, PA TCV

Client Sample ID: TT-04A

Date Collected: 10/28/14 10:00 Date Received: 11/03/14 16:10 Lab Sample ID: 180-38441-7

TestAmerica Job ID: 180-38441-1

Matrix: Solid

Percent Solids: 90.6

Analyte	Result Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fa
Carbazole	110	73	6.7	ug/Kg	₩	11/05/14 03:00	11/13/14 19:32	
4-Chloroaniline	ND	360	29	ug/Kg	\$	11/05/14 03:00	11/13/14 19:32	
2-Chloronaphthalene	ND	73	7.6	ug/Kg	₽	11/05/14 03:00	11/13/14 19:32	
4-Chlorophenyl phenyl ether	ND	360	41	ug/Kg	\$	11/05/14 03:00	11/13/14 19:32	
Chrysene	1000	73	8.7	ug/Kg	₩	11/05/14 03:00	11/13/14 19:32	
Dibenz(a,h)anthracene	280	73	8.1	ug/Kg	₩	11/05/14 03:00	11/13/14 19:32	
Dibenzofuran	92 J	360	36	ug/Kg	φ.	11/05/14 03:00	11/13/14 19:32	
Di-n-butyl phthalate	ND	360	46	ug/Kg	₽	11/05/14 03:00	11/13/14 19:32	
3,3'-Dichlorobenzidine	ND	360	39	ug/Kg	₽	11/05/14 03:00	11/13/14 19:32	
Diethyl phthalate	41 J	360	40	ug/Kg		11/05/14 03:00	11/13/14 19:32	
Dimethyl phthalate	ND	360	40	ug/Kg	₽	11/05/14 03:00	11/13/14 19:32	
2,4-Dinitrotoluene	ND	360	30	ug/Kg	₩	11/05/14 03:00	11/13/14 19:32	
2,6-Dinitrotoluene	ND	360	38	ug/Kg		11/05/14 03:00	11/13/14 19:32	
Di-n-octyl phthalate	ND	360	39	ug/Kg	₽	11/05/14 03:00	11/13/14 19:32	
Fluoranthene	1500	73	7.8	ug/Kg	₽	11/05/14 03:00	11/13/14 19:32	
Fluorene	86	73				11/05/14 03:00	11/13/14 19:32	
Hexachlorobenzene	ND	73	7.8	ug/Kg	₽	11/05/14 03:00	11/13/14 19:32	
Hexachlorobutadiene	ND	73		ug/Kg	₩	11/05/14 03:00	11/13/14 19:32	
Hexachlorocyclopentadiene	ND	360	39	ug/Kg ug/Kg		11/05/14 03:00	11/13/14 19:32	
Hexachloroethane	ND	360	26	ug/Kg ug/Kg		11/05/14 03:00	11/13/14 19:32	
	870	73	7.5			11/05/14 03:00	11/13/14 19:32	
Indeno[1,2,3-cd]pyrene	870 ND	360				11/05/14 03:00	11/13/14 19:32	
Isophorone			28	ug/Kg	₩			
2-Methylnaphthalene	84	73	6.6	ug/Kg		11/05/14 03:00	11/13/14 19:32	
Naphthalene	160	73	6.3		<u></u> .	11/05/14 03:00	11/13/14 19:32	
2-Nitroaniline	ND	1900	160	ug/Kg	*	11/05/14 03:00	11/13/14 19:32	
3-Nitroaniline	ND	1900	150	ug/Kg	‡	11/05/14 03:00	11/13/14 19:32	
4-Nitroaniline	ND	1900	150	ug/Kg	<u>T</u> .	11/05/14 03:00	11/13/14 19:32	
4-Nitrophenol	ND	1900	130	ug/Kg	₩	11/05/14 03:00	11/13/14 19:32	
Nitrobenzene	ND	730	30	ug/Kg	₩	11/05/14 03:00	11/13/14 19:32	
N-Nitrosodi-n-propylamine	ND	73		ug/Kg	<u>.</u>	11/05/14 03:00	11/13/14 19:32	
N-Nitrosodiphenylamine	ND	360		ug/Kg	\$	11/05/14 03:00	11/13/14 19:32	
Phenanthrene	920	73	12	ug/Kg	₽	11/05/14 03:00	11/13/14 19:32	
Pyrene	1200	73	7.4	ug/Kg		11/05/14 03:00	11/13/14 19:32	
4-Chloro-3-methylphenol	ND	360	34	ug/Kg	₽	11/05/14 03:00	11/13/14 19:32	
2-Chlorophenol	ND	360	30	ug/Kg	₩	11/05/14 03:00	11/13/14 19:32	
2-Methylphenol	ND	360	26	ug/Kg	₽	11/05/14 03:00	11/13/14 19:32	
Methylphenol, 3 & 4	ND	360	36	ug/Kg	₩	11/05/14 03:00	11/13/14 19:32	
2,4-Dichlorophenol	ND	73	7.3	ug/Kg	₩	11/05/14 03:00	11/13/14 19:32	
2,4-Dimethylphenol	ND	360	57	ug/Kg	₩	11/05/14 03:00	11/13/14 19:32	
2,4-Dinitrophenol	ND	1900	440	ug/Kg	₽	11/05/14 03:00	11/13/14 19:32	
4,6-Dinitro-2-methylphenol	ND	1900	150	ug/Kg	₽	11/05/14 03:00	11/13/14 19:32	
2-Nitrophenol	ND	360	40	ug/Kg	₽	11/05/14 03:00	11/13/14 19:32	
Pentachlorophenol	ND	360	33	ug/Kg		11/05/14 03:00	11/13/14 19:32	
Phenol	ND	73	8.6	ug/Kg	₩	11/05/14 03:00	11/13/14 19:32	
2,4,5-Trichlorophenol	ND	360		ug/Kg	₩	11/05/14 03:00	11/13/14 19:32	
2,4,6-Trichlorophenol	ND	360		ug/Kg		11/05/14 03:00	11/13/14 19:32	
Acetophenone	ND	360	30	ug/Kg	₽	11/05/14 03:00	11/13/14 19:32	
Atrazine	ND	360			₽	11/05/14 03:00	11/13/14 19:32	
Benzaldehyde	ND	360		ug/Kg	 \$	11/05/14 03:00	11/13/14 19:32	

TestAmerica Pittsburgh

2

6

a

10

11

13

Project/Site: Center Street Parcel, McKeesport, PA TCV

Client Sample ID: TT-04A

Client: KU Resources Inc

General Chemistry

Percent Moisture

Analyte

Lab Sample ID: 180-38441-7

Date Collected: 10/28/14 10:00 Matrix: Solid Date Received: 11/03/14 16:10 Percent Solids: 90.6

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1'-Biphenyl	ND		360	33	ug/Kg	<u></u>	11/05/14 03:00	11/13/14 19:32	1
Caprolactam	ND		1900	280	ug/Kg	₽	11/05/14 03:00	11/13/14 19:32	1
Bis(2-chloroethoxy)methane	ND		360	24	ug/Kg	₽	11/05/14 03:00	11/13/14 19:32	1
Bis(2-chloroethyl)ether	ND		73	9.8	ug/Kg	₩	11/05/14 03:00	11/13/14 19:32	1
Surrogate	%Recovery	Qualifier	Limits				Prepared	Analyzed	Dil Fac
Nitrobenzene-d5 (Surr)	83		25 - 104				11/05/14 03:00	11/13/14 19:32	1
Phenol-d5 (Surr)	69		25 - 105				11/05/14 03:00	11/13/14 19:32	1
2-Fluorobiphenyl	69		35 - 105				11/05/14 03:00	11/13/14 19:32	1
2,4,6-Tribromophenol (Surr)	54		35 - 124				11/05/14 03:00	11/13/14 19:32	1
2-Fluorophenol (Surr)	58		39 - 103				11/05/14 03:00	11/13/14 19:32	1
2-1 ladiophenol (Sali)									
Terphenyl-d14 (Surr)	64		25 - 127				11/05/14 03:00	11/13/14 19:32	1
Terphenyl-d14 (Surr)							11/05/14 03:00	11/13/14 19:32	1
, ,	ted Biphenyls (PC	, ,	s Chromatograp	•					
Terphenyl-d14 (Surr)	ted Biphenyls (PC	CBs) by Gas Qualifier		ohy MDL	Unit	<u>D</u>	11/05/14 03:00 Prepared	11/13/14 19:32 Analyzed	1 Dil Fac
Terphenyl-d14 (Surr) Method: 8082A - Polychlorinat	ted Biphenyls (PC	, ,	s Chromatograp	•	Unit ug/Kg	D			
Terphenyl-d14 (Surr) Method: 8082A - Polychlorinat Analyte	ted Biphenyls (PC	, ,	S Chromatograp	MDL 3.7	ug/Kg		Prepared	Analyzed	
Terphenyl-d14 (Surr) Method: 8082A - Polychlorinat Analyte PCB-1016	ted Biphenyls (POResult ND	, ,	Chromatograp RL 18	3.7 4.6	ug/Kg		Prepared 11/06/14 03:45	Analyzed 11/08/14 06:18	Dil Fac
Terphenyl-d14 (Surr) Method: 8082A - Polychlorinal Analyte PCB-1016 PCB-1221	ted Biphenyls (PC Result ND ND	, ,	Chromatograp RL 18	3.7 4.6 6.3	ug/Kg ug/Kg	*	Prepared 11/06/14 03:45 11/06/14 03:45	Analyzed 11/08/14 06:18 11/08/14 06:18	Dil Fac
Terphenyl-d14 (Surr) Method: 8082A - Polychlorinat Analyte PCB-1016 PCB-1221 PCB-1232	ted Biphenyls (PC Result ND ND ND	, ,	8 Chromatograp RL 18 18 18	3.7 4.6 6.3 4.6	ug/Kg ug/Kg ug/Kg	* *	Prepared 11/06/14 03:45 11/06/14 03:45 11/06/14 03:45	Analyzed 11/08/14 06:18 11/08/14 06:18 11/08/14 06:18	Dil Fac 1 1
Method: 8082A - Polychlorinat Analyte PCB-1016 PCB-1221 PCB-1232 PCB-1242	ted Biphenyls (PC Result ND ND ND ND	, ,	8 Chromatograp RL 18 18 18 18	3.7 4.6 6.3 4.6 4.5	ug/Kg ug/Kg ug/Kg ug/Kg	* * *	Prepared 11/06/14 03:45 11/06/14 03:45 11/06/14 03:45 11/06/14 03:45	Analyzed 11/08/14 06:18 11/08/14 06:18 11/08/14 06:18 11/08/14 06:18	Dil Fac 1 1 1 1
Terphenyl-d14 (Surr) Method: 8082A - Polychlorinat Analyte PCB-1016 PCB-1221 PCB-1232 PCB-1242 PCB-1248	ted Biphenyls (PC Result ND ND ND ND ND ND ND ND	, ,	8 Chromatograp RL 18 18 18 18 18	MDL 3.7 4.6 6.3 4.6 4.5 4.3	ug/Kg ug/Kg ug/Kg ug/Kg ug/Kg	*	Prepared 11/06/14 03:45 11/06/14 03:45 11/06/14 03:45 11/06/14 03:45	Analyzed 11/08/14 06:18 11/08/14 06:18 11/08/14 06:18 11/08/14 06:18 11/08/14 06:18	Dil Fac 1 1 1 1 1 1
Terphenyl-d14 (Surr) Method: 8082A - Polychlorinat Analyte PCB-1016 PCB-1221 PCB-1232 PCB-1242 PCB-1248 PCB-1254	ted Biphenyls (PC Result ND ND ND ND ND	Qualifier	8 Chromatograp RL 18 18 18 18 18 18	MDL 3.7 4.6 6.3 4.6 4.5 4.3	ug/Kg ug/Kg ug/Kg ug/Kg ug/Kg ug/Kg	* * * * * * * * * * * * * * * * * * *	Prepared 11/06/14 03:45 11/06/14 03:45 11/06/14 03:45 11/06/14 03:45 11/06/14 03:45	Analyzed 11/08/14 06:18 11/08/14 06:18 11/08/14 06:18 11/08/14 06:18 11/08/14 06:18	Dil Fac 1 1 1 1 1 1 1 1 1
Method: 8082A - Polychlorinat Analyte PCB-1016 PCB-1221 PCB-1232 PCB-1242 PCB-1248 PCB-1254 PCB-1260	ND ND ND ND ND ND ND ND ND ND ND ND ND N	Qualifier	8 Chromatograp RL 18 18 18 18 18 18 18 18	MDL 3.7 4.6 6.3 4.6 4.5 4.3	ug/Kg ug/Kg ug/Kg ug/Kg ug/Kg ug/Kg	* * * * * * * * * * * * * * * * * * *	Prepared 11/06/14 03:45 11/06/14 03:45 11/06/14 03:45 11/06/14 03:45 11/06/14 03:45 11/06/14 03:45	Analyzed 11/08/14 06:18 11/08/14 06:18 11/08/14 06:18 11/08/14 06:18 11/08/14 06:18 11/08/14 06:18	Dil Fac 1 1 1 1 1 1 1 1 1

Client Sample ID: TT-04B	Lab Sample ID: 180-38441-8

RL

0.10

MDL Unit

0.10 %

D

Prepared

Analyzed

11/05/14 15:02

Dil Fac

Result Qualifier

9.4

Date Collected: 10/28/14 10:30 **Matrix: Solid** Date Received: 11/03/14 16:10 Percent Solids: 89.8

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Acenaphthene	27	J	75	7.1	ug/Kg	₩	11/05/14 03:00	11/13/14 20:01	1
Acenaphthylene	210		75	8.5	ug/Kg	₽	11/05/14 03:00	11/13/14 20:01	1
Anthracene	250		75	7.3	ug/Kg	₽	11/05/14 03:00	11/13/14 20:01	1
Benzo[a]anthracene	960		75	9.3	ug/Kg	\$	11/05/14 03:00	11/13/14 20:01	1
Benzo[a]pyrene	740		75	7.4	ug/Kg	₽	11/05/14 03:00	11/13/14 20:01	1
Benzo[b]fluoranthene	1200		75	12	ug/Kg	₽	11/05/14 03:00	11/13/14 20:01	1
Benzo[g,h,i]perylene	840		75	7.4	ug/Kg	₽	11/05/14 03:00	11/13/14 20:01	1
Benzo[k]fluoranthene	450		75	15	ug/Kg	₽	11/05/14 03:00	11/13/14 20:01	1
Bis(2-ethylhexyl) phthalate	ND		750	60	ug/Kg	₽	11/05/14 03:00	11/13/14 20:01	1
2,2'-oxybis[1-chloropropane]	ND		75	8.0	ug/Kg	₽	11/05/14 03:00	11/13/14 20:01	1
4-Bromophenyl phenyl ether	ND		370	32	ug/Kg	₽	11/05/14 03:00	11/13/14 20:01	1
Butyl benzyl phthalate	ND		370	51	ug/Kg	☼	11/05/14 03:00	11/13/14 20:01	1
Carbazole	110		75	6.8	ug/Kg	₽	11/05/14 03:00	11/13/14 20:01	1
4-Chloroaniline	ND		370	30	ug/Kg	⇔	11/05/14 03:00	11/13/14 20:01	1

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Client: KU Resources Inc

Project/Site: Center Street Parcel, McKeesport, PA TCV

Client Comple ID: TT 04D

Client Sample ID: TT-04B Lab Sample ID: 180-38441-8

Date Collected: 10/28/14 10:30 Matrix: Solid
Date Received: 11/03/14 16:10 Percent Solids: 89.8

Method: 8270D - Semivolatile O Analyte	•	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fa
2-Chloronaphthalene	ND		75	7.8	ug/Kg	<u></u>	11/05/14 03:00	11/13/14 20:01	
4-Chlorophenyl phenyl ether	ND		370	41	ug/Kg	φ.	11/05/14 03:00	11/13/14 20:01	
Chrysene	880		75	8.8	ug/Kg	₽	11/05/14 03:00	11/13/14 20:01	
Dibenz(a,h)anthracene	210		75	8.3	ug/Kg	₽	11/05/14 03:00	11/13/14 20:01	
Dibenzofuran	160		370	37	ug/Kg		11/05/14 03:00	11/13/14 20:01	
Di-n-butyl phthalate	ND		370	47	ug/Kg	₽	11/05/14 03:00	11/13/14 20:01	
3,3'-Dichlorobenzidine	ND		370	39	ug/Kg	₽	11/05/14 03:00	11/13/14 20:01	
Diethyl phthalate	43		370	41	ug/Kg		11/05/14 03:00	11/13/14 20:01	
Dimethyl phthalate	ND		370	40	ug/Kg	₽	11/05/14 03:00	11/13/14 20:01	
2,4-Dinitrotoluene	ND		370	30	ug/Kg	₩	11/05/14 03:00	11/13/14 20:01	
2,6-Dinitrotoluene	ND		370	38	ug/Kg	ф.	11/05/14 03:00	11/13/14 20:01	
Di-n-octyl phthalate	ND		370	39	ug/Kg	₽	11/05/14 03:00	11/13/14 20:01	
Fluoranthene	1400		75	7.9	ug/Kg	₽	11/05/14 03:00	11/13/14 20:01	
Fluorene	85		75	9.8	ug/Kg	ф.	11/05/14 03:00	11/13/14 20:01	
Hexachlorobenzene	ND		75	7.9	ug/Kg	☼	11/05/14 03:00	11/13/14 20:01	
Hexachlorobutadiene	ND		75	8.3	ug/Kg	☼	11/05/14 03:00	11/13/14 20:01	
Hexachlorocyclopentadiene	ND		370	40	ug/Kg	ф.	11/05/14 03:00	11/13/14 20:01	
Hexachloroethane	ND		370	27	ug/Kg	₽	11/05/14 03:00	11/13/14 20:01	
Indeno[1,2,3-cd]pyrene	700		75	7.7	ug/Kg	₩	11/05/14 03:00	11/13/14 20:01	
Isophorone	ND		370	28	ug/Kg		11/05/14 03:00	11/13/14 20:01	
2-Methylnaphthalene	140		75	6.7	ug/Kg	₽	11/05/14 03:00	11/13/14 20:01	
Naphthalene	330		75	6.4	ug/Kg	₩	11/05/14 03:00	11/13/14 20:01	
2-Nitroaniline	ND		1900	170	ug/Kg		11/05/14 03:00	11/13/14 20:01	
3-Nitroaniline	ND		1900	150	ug/Kg	₩	11/05/14 03:00	11/13/14 20:01	
4-Nitroaniline	ND		1900	150	ug/Kg	₽	11/05/14 03:00	11/13/14 20:01	
4-Nitrophenol	ND		1900	140	ug/Kg	· · · · · · · · · · · · · · · · · · ·	11/05/14 03:00	11/13/14 20:01	
Nitrobenzene	ND		750	31	ug/Kg	₩	11/05/14 03:00	11/13/14 20:01	
N-Nitrosodi-n-propylamine	ND		75	8.7		₽	11/05/14 03:00	11/13/14 20:01	
N-Nitrosodiphenylamine	ND		370	34	ug/Kg		11/05/14 03:00	11/13/14 20:01	
Phenanthrene	990		75	12	ug/Kg	₽	11/05/14 03:00	11/13/14 20:01	
Pyrene	1100		75		ug/Kg	₽	11/05/14 03:00	11/13/14 20:01	
4-Chloro-3-methylphenol	ND		370		ug/Kg	· · · · · · · · · · · · · · · · · · ·	11/05/14 03:00	11/13/14 20:01	
2-Chlorophenol	ND		370	30	ug/Kg	₩	11/05/14 03:00	11/13/14 20:01	
2-Methylphenol	ND		370	26	ug/Kg	₽	11/05/14 03:00	11/13/14 20:01	
Methylphenol, 3 & 4	ND		370	36	ug/Kg		11/05/14 03:00	11/13/14 20:01	
2,4-Dichlorophenol	ND		75		ug/Kg	₽	11/05/14 03:00	11/13/14 20:01	
2,4-Dimethylphenol	ND		370		ug/Kg	₽	11/05/14 03:00	11/13/14 20:01	
2,4-Dinitrophenol	ND		1900	440	ug/Kg		11/05/14 03:00	11/13/14 20:01	
4,6-Dinitro-2-methylphenol	ND		1900	150	ug/Kg	₽	11/05/14 03:00	11/13/14 20:01	
2-Nitrophenol	ND		370	41	ug/Kg	₽	11/05/14 03:00	11/13/14 20:01	
Pentachlorophenol	ND		370	33	ug/Kg		11/05/14 03:00	11/13/14 20:01	
Phenol	ND		75	8.8	ug/Kg	₽	11/05/14 03:00	11/13/14 20:01	
2,4,5-Trichlorophenol	ND		370	40	ug/Kg	₽	11/05/14 03:00	11/13/14 20:01	
2,4,6-Trichlorophenol	ND		370		ug/Kg		11/05/14 03:00	11/13/14 20:01	
Acetophenone	ND		370	31	ug/Kg	₽	11/05/14 03:00	11/13/14 20:01	
Atrazine	ND		370		ug/Kg	₽	11/05/14 03:00	11/13/14 20:01	
Benzaldehyde	ND		370		ug/Kg		11/05/14 03:00	11/13/14 20:01	
1,1'-Biphenyl	44	a.	370	33	ug/Kg	₽	11/05/14 03:00	11/13/14 20:01	
Caprolactam	ND	•	1900		ug/Kg ug/Kg	₽	11/05/14 03:00	11/13/14 20:01	

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TestAmerica Job ID: 180-38441-1

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Client: KU Resources Inc

Project/Site: Center Street Parcel, McKeesport, PA TCV

Client Sample ID: TT-04B Lab Sample ID: 180-38441-8

Date Collected: 10/28/14 10:30

Matrix: Solid Date Received: 11/03/14 16:10

Percent Solids: 89.8

TestAmerica Job ID: 180-38441-1

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Bis(2-chloroethoxy)methane	ND		370	24	ug/Kg	₩	11/05/14 03:00	11/13/14 20:01	1
Bis(2-chloroethyl)ether	ND		75	10	ug/Kg	₽	11/05/14 03:00	11/13/14 20:01	1
Surrogate	%Recovery	Qualifier	Limits				Prepared	Analyzed	Dil Fac
Nitrobenzene-d5 (Surr)	84		25 - 104				11/05/14 03:00	11/13/14 20:01	1
Phenol-d5 (Surr)	70		25 - 105				11/05/14 03:00	11/13/14 20:01	1
2-Fluorobiphenyl	70		35 - 105				11/05/14 03:00	11/13/14 20:01	1
2,4,6-Tribromophenol (Surr)	63		35 - 124				11/05/14 03:00	11/13/14 20:01	1
2-Fluorophenol (Surr)	58		39 - 103				11/05/14 03:00	11/13/14 20:01	1
Tombonid d11 (Circl)							44/05/44 00 00	44404440004	
Terphenyl-d14 (Surr)	66		25 - 127				11/05/14 03:00	11/13/14 20:01	1
, , , ,		CBs) by Gas		hv			11/05/14 03:00	11/13/14 20:01	1
nerpnenyr-a14 (Surr) Method: 8082A - Polychlorina Analyte	ated Biphenyls (PC	CBs) by Gas Qualifier		ohy MDL	Unit	D	11/05/14 03:00 Prepared	11/13/14 20:01 Analyzed	1 Dil Fac
Method: 8082A - Polychlorina	ated Biphenyls (PC		s Chromatograp	•	Unit ug/Kg	D \$\overline{\pi}\$			Dil Fac
Method: 8082A - Polychlorina Analyte	ated Biphenyls (PC		s Chromatograp	MDL			Prepared	Analyzed	Dil Fac 1
Method: 8082A - Polychlorina Analyte PCB-1016	ated Biphenyls (PC Result ND		S Chromatograp RL 19	3.8 4.7	ug/Kg ug/Kg	<u> </u>	Prepared 11/06/14 03:45	Analyzed 11/08/14 06:50	Dil Fac 1 1 1
Method: 8082A - Polychlorina Analyte PCB-1016 PCB-1221	ated Biphenyls (PC Result ND ND		S Chromatograp RL 19	3.8 4.7	ug/Kg ug/Kg	<u> </u>	Prepared 11/06/14 03:45 11/06/14 03:45	Analyzed 11/08/14 06:50 11/08/14 06:50	Dil Fac 1 1 1 1
Method: 8082A - Polychlorina Analyte PCB-1016 PCB-1221 PCB-1232	ated Biphenyls (PC Result ND ND ND		S Chromatograp RL 19 19 19	3.8 4.7 6.4	ug/Kg ug/Kg ug/Kg		Prepared 11/06/14 03:45 11/06/14 03:45 11/06/14 03:45	Analyzed 11/08/14 06:50 11/08/14 06:50 11/08/14 06:50	Dil Fac 1 1 1 1 1 1 1
Method: 8082A - Polychlorina Analyte PCB-1016 PCB-1221 PCB-1232 PCB-1242	ated Biphenyls (PC Result ND ND ND ND		S Chromatograp RL 19 19 19 19	3.8 4.7 6.4 4.7 4.6	ug/Kg ug/Kg ug/Kg ug/Kg	# # #	Prepared 11/06/14 03:45 11/06/14 03:45 11/06/14 03:45 11/06/14 03:45	Analyzed 11/08/14 06:50 11/08/14 06:50 11/08/14 06:50 11/08/14 06:50	Dil Fac 1 1 1 1 1 1 1 1 1

Surrogate	%Recovery Qualifier	Limits	Prepared	Analyzed	Dil Fac
Tetrachloro-m-xylene (Surr)	76	45 - 135	11/06/14 03:45	11/08/14 06:50	1
DCB Decachlorobiphenyl (Surr)	87	45 - 125	11/06/14 03:45	11/08/14 06:50	1

	General Chemistry									
	Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
l	Percent Moisture	10		0.10	0.10	%			11/05/14 15:02	1

11/17/2014

QC Sample Results

Client: KU Resources Inc

Project/Site: Center Street Parcel, McKeesport, PA TCV

TestAmerica Job ID: 180-38441-1

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Lab Sample ID: MB 180-123937/1-A

Matrix: Solid

Analysis Batch: 124983

Client Sample ID: Method Blank Prep Type: Total/NA

Prep Batch: 123937

	MB	MB							
Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Acenaphthene	ND		67	6.4	ug/Kg		11/05/14 03:00	11/13/14 14:41	-
Acenaphthylene	ND		67	7.6	ug/Kg		11/05/14 03:00	11/13/14 14:41	•
Anthracene	ND		67	6.5	ug/Kg		11/05/14 03:00	11/13/14 14:41	
Benzo[a]anthracene	ND		67	8.4	ug/Kg		11/05/14 03:00	11/13/14 14:41	
Benzo[a]pyrene	ND		67	6.7	ug/Kg		11/05/14 03:00	11/13/14 14:41	•
Benzo[b]fluoranthene	ND		67	10	ug/Kg		11/05/14 03:00	11/13/14 14:41	
Benzo[g,h,i]perylene	ND		67	6.6	ug/Kg		11/05/14 03:00	11/13/14 14:41	
Benzo[k]fluoranthene	ND		67	13	ug/Kg		11/05/14 03:00	11/13/14 14:41	
Bis(2-ethylhexyl) phthalate	ND		670	54	ug/Kg		11/05/14 03:00	11/13/14 14:41	•
2,2'-oxybis[1-chloropropane]	ND		67	7.2	ug/Kg		11/05/14 03:00	11/13/14 14:41	
4-Bromophenyl phenyl ether	ND		330	29	ug/Kg		11/05/14 03:00	11/13/14 14:41	
Butyl benzyl phthalate	ND		330	46	ug/Kg		11/05/14 03:00	11/13/14 14:41	•
Carbazole	ND		67	6.1	ug/Kg		11/05/14 03:00	11/13/14 14:41	
4-Chloroaniline	ND		330	27	ug/Kg		11/05/14 03:00	11/13/14 14:41	
2-Chloronaphthalene	ND		67	7.0	ug/Kg		11/05/14 03:00	11/13/14 14:41	
4-Chlorophenyl phenyl ether	ND		330	37	ug/Kg		11/05/14 03:00	11/13/14 14:41	
Chrysene	ND		67	7.9	ug/Kg		11/05/14 03:00	11/13/14 14:41	
Dibenz(a,h)anthracene	ND		67	7.4	ug/Kg		11/05/14 03:00	11/13/14 14:41	•
Dibenzofuran	ND		330	33	ug/Kg		11/05/14 03:00	11/13/14 14:41	•
Di-n-butyl phthalate	ND		330	42	ug/Kg		11/05/14 03:00	11/13/14 14:41	•
3,3'-Dichlorobenzidine	ND		330	35	ug/Kg		11/05/14 03:00	11/13/14 14:41	•
Diethyl phthalate	ND		330	36	ug/Kg		11/05/14 03:00	11/13/14 14:41	
Dimethyl phthalate	ND		330	36	ug/Kg		11/05/14 03:00	11/13/14 14:41	•
2,4-Dinitrotoluene	ND		330	27	ug/Kg		11/05/14 03:00	11/13/14 14:41	
2,6-Dinitrotoluene	ND		330	34	ug/Kg		11/05/14 03:00	11/13/14 14:41	
Di-n-octyl phthalate	ND		330	35	ug/Kg		11/05/14 03:00	11/13/14 14:41	
Fluoranthene	ND		67	7.1	ug/Kg		11/05/14 03:00	11/13/14 14:41	•
Fluorene	ND		67	8.8	ug/Kg		11/05/14 03:00	11/13/14 14:41	
Hexachlorobenzene	ND		67	7.1	ug/Kg		11/05/14 03:00	11/13/14 14:41	•
Hexachlorobutadiene	ND		67	7.5	ug/Kg		11/05/14 03:00	11/13/14 14:41	•
Hexachlorocyclopentadiene	ND		330	36	ug/Kg		11/05/14 03:00	11/13/14 14:41	
Hexachloroethane	ND		330	24	ug/Kg		11/05/14 03:00	11/13/14 14:41	•
Indeno[1,2,3-cd]pyrene	ND		67	6.9	ug/Kg		11/05/14 03:00	11/13/14 14:41	•
Isophorone	ND		330	25	ug/Kg		11/05/14 03:00	11/13/14 14:41	
2-Methylnaphthalene	ND		67	6.0	ug/Kg		11/05/14 03:00	11/13/14 14:41	•
Naphthalene	ND		67	5.7	ug/Kg		11/05/14 03:00	11/13/14 14:41	
2-Nitroaniline	ND		1700	150	ug/Kg		11/05/14 03:00	11/13/14 14:41	
3-Nitroaniline	ND		1700	140	ug/Kg		11/05/14 03:00	11/13/14 14:41	
4-Nitroaniline	ND		1700	140	ug/Kg		11/05/14 03:00	11/13/14 14:41	
4-Nitrophenol	ND		1700	120	ug/Kg		11/05/14 03:00	11/13/14 14:41	
Nitrobenzene	ND		670	28	ug/Kg		11/05/14 03:00	11/13/14 14:41	
N-Nitrosodi-n-propylamine	ND		67	7.8	ug/Kg		11/05/14 03:00	11/13/14 14:41	•
N-Nitrosodiphenylamine	ND		330	31	ug/Kg		11/05/14 03:00	11/13/14 14:41	
Phenanthrene	ND		67	11	ug/Kg		11/05/14 03:00	11/13/14 14:41	
Pyrene	ND		67	6.7	ug/Kg		11/05/14 03:00	11/13/14 14:41	
4-Chloro-3-methylphenol	ND		330	31	ug/Kg		11/05/14 03:00	11/13/14 14:41	
2-Chlorophenol	ND		330	27	ug/Kg		11/05/14 03:00	11/13/14 14:41	•
2-Methylphenol	ND		330	23	ug/Kg		11/05/14 03:00	11/13/14 14:41	

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Client: KU Resources Inc Project/Site: Center Street Parcel, McKeesport, PA TCV

Method: 8270D - Semivolatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: MB 180-123937/1-A

Matrix: Solid

Analysis Batch: 124983

Client Sample ID: Method Blank **Prep Type: Total/NA**

Prep Batch: 123937

	MB	MB							
Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Methylphenol, 3 & 4	ND		330	33	ug/Kg		11/05/14 03:00	11/13/14 14:41	1
2,4-Dichlorophenol	ND		67	6.7	ug/Kg		11/05/14 03:00	11/13/14 14:41	1
2,4-Dimethylphenol	ND		330	52	ug/Kg		11/05/14 03:00	11/13/14 14:41	1
2,4-Dinitrophenol	ND		1700	400	ug/Kg		11/05/14 03:00	11/13/14 14:41	1
4,6-Dinitro-2-methylphenol	ND		1700	130	ug/Kg		11/05/14 03:00	11/13/14 14:41	1
2-Nitrophenol	ND		330	37	ug/Kg		11/05/14 03:00	11/13/14 14:41	1
Pentachlorophenol	ND		330	30	ug/Kg		11/05/14 03:00	11/13/14 14:41	1
Phenol	ND		67	7.9	ug/Kg		11/05/14 03:00	11/13/14 14:41	1
2,4,5-Trichlorophenol	ND		330	36	ug/Kg		11/05/14 03:00	11/13/14 14:41	1
2,4,6-Trichlorophenol	ND		330	50	ug/Kg		11/05/14 03:00	11/13/14 14:41	1
Acetophenone	ND		330	27	ug/Kg		11/05/14 03:00	11/13/14 14:41	1
Atrazine	ND		330	32	ug/Kg		11/05/14 03:00	11/13/14 14:41	1
Benzaldehyde	ND		330	50	ug/Kg		11/05/14 03:00	11/13/14 14:41	1
1,1'-Biphenyl	ND		330	30	ug/Kg		11/05/14 03:00	11/13/14 14:41	1
Caprolactam	ND		1700	250	ug/Kg		11/05/14 03:00	11/13/14 14:41	1
Bis(2-chloroethoxy)methane	ND		330	22	ug/Kg		11/05/14 03:00	11/13/14 14:41	1
Bis(2-chloroethyl)ether	ND		67	9.0	ug/Kg		11/05/14 03:00	11/13/14 14:41	1

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Surrogate	%Recovery	Qualifier	Limits	Prepared	Analyzed	Dil Fac
Nitrobenzene-d5 (Surr)	76		25 - 104	11/05/14 03:00	11/13/14 14:41	1
Phenol-d5 (Surr)	66		25 - 105	11/05/14 03:00	11/13/14 14:41	1
2-Fluorobiphenyl	65		35 - 105	11/05/14 03:00	11/13/14 14:41	1
2,4,6-Tribromophenol (Surr)	62		35 - 124	11/05/14 03:00	11/13/14 14:41	1
2-Fluorophenol (Surr)	64		39 - 103	11/05/14 03:00	11/13/14 14:41	1
Terphenyl-d14 (Surr)	76		25 - 127	11/05/14 03:00	11/13/14 14:41	1

Lab Sample ID: LCS 180-123937/2-A

Matrix: Solid

Analysis Batch: 124983

Client Sample ID: Lab Control Sample Prep Type: Total/NA **Prep Batch: 123937**

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•	Spike	LCS	LCS				%Rec.	
Analyte	Added	Result	Qualifier	Unit	D	%Rec	Limits	
Acenaphthene	6670	4760		ug/Kg		71	47 - 104	
Acenaphthylene	6670	4870		ug/Kg		73	49 - 114	
Anthracene	6670	4980		ug/Kg		75	45 - 112	
Benzo[a]anthracene	6670	5310		ug/Kg		80	47 - 110	
Benzo[a]pyrene	6670	5150		ug/Kg		77	47 - 112	
Benzo[b]fluoranthene	6670	5050		ug/Kg		76	41 - 107	
Benzo[g,h,i]perylene	6670	5240		ug/Kg		79	38 - 126	
Benzo[k]fluoranthene	6670	4680		ug/Kg		70	44 - 115	
Bis(2-ethylhexyl) phthalate	6670	6220		ug/Kg		93	40 - 122	
2,2'-oxybis[1-chloropropane]	6670	4210		ug/Kg		63	36 - 101	
4-Bromophenyl phenyl ether	6670	4430		ug/Kg		66	47 - 110	
Butyl benzyl phthalate	6670	5830		ug/Kg		87	41 - 118	
Carbazole	6670	5000		ug/Kg		75	45 - 114	
4-Chloroaniline	6670	4710		ug/Kg		71	25 - 108	
2-Chloronaphthalene	6670	4020		ug/Kg		60	46 - 101	
4-Chlorophenyl phenyl ether	6670	5180		ug/Kg		78	47 - 109	
Chrysene	6670	5360		ug/Kg		80	46 - 111	

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QC Sample Results

Client: KU Resources Inc

Project/Site: Center Street Parcel, McKeesport, PA TCV

TestAmerica Job ID: 180-38441-1

Method: 8270D - Semivolatile Organic Compounds (GC/MS) (Continued)

Lab	Sam	pie iu	: LCS	180-1	2393	//2-A

Matrix: Solid

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 123937

Analysis Batch: 124983 LCS LCS Spike %Rec. Result Qualifier Analyte Added Unit %Rec Limits 6670 5260 79 Dibenz(a,h)anthracene ug/Kg 39 - 127 Dibenzofuran 6670 4900 ug/Kg 73 46 - 104 6670 Di-n-butyl phthalate 5140 ug/Kg 77 43 - 121 3,3'-Dichlorobenzidine 6670 4670 ug/Kg 70 19 - 122 6670 5350 80 47 - 115 Diethyl phthalate ug/Kg 6670 5250 79 49 - 111 Dimethyl phthalate ug/Kg 2,4-Dinitrotoluene 6670 5590 84 45 _ 124 ug/Kg 2,6-Dinitrotoluene 6670 5240 ug/Kg 79 50 - 122 Di-n-octyl phthalate 6670 5640 ug/Kg 85 33 - 129 Fluoranthene 6670 5280 ug/Kg 79 40 - 120 Fluorene 6670 5430 82 46 - 109 ug/Kg 65 Hexachlorobenzene 6670 4320 ug/Kg 47 - 108 Hexachlorobutadiene 6670 5430 ug/Kg 82 43 - 107 75 Hexachlorocyclopentadiene 6670 5010 ug/Kg 23 - 129 6670 74 Hexachloroethane 4960 ug/Kg 37 - 97Indeno[1,2,3-cd]pyrene 6670 5110 77 41 - 125 ug/Kg 6670 83 47 - 110 Isophorone 5550 ug/Kg 6670 77 2-Methylnaphthalene 5140 ug/Kg 45 - 100 Naphthalene 6670 4840 73 43 - 100 ug/Kg 2-Nitroaniline 6670 5790 87 45 _ 117 ug/Kg 3-Nitroaniline 6670 4710 71 34 - 122 ug/Kg 4-Nitroaniline 6670 4650 70 38 - 123 ug/Kg 4-Nitrophenol 13300 12600 ug/Kg 95 36 - 127 6670 5380 81 Nitrobenzene ug/Kg 43 _ 104 N-Nitrosodi-n-propylamine 6670 5370 ug/Kg 81 42 - 107 N-Nitrosodiphenylamine 6670 4530 ug/Kg 68 44 - 111 Phenanthrene 6670 72 43 - 108 4810 ug/Kg 6670 77 Pyrene 5140 ug/Kg 41 - 115 4-Chloro-3-methylphenol 6670 5730 ug/Kg 86 47 - 1092-Chlorophenol 6670 4680 ug/Kg 70 40 - 101 6670 4860 73 2-Methylphenol ug/Kg 40 - 104 Methylphenol, 3 & 4 6670 4760 ug/Kg 71 42 - 105 2,4-Dichlorophenol 6670 5300 ug/Kg 79 47 _ 105 2,4-Dimethylphenol 6670 5490 ug/Kg 82 44 - 105 77 2,4-Dinitrophenol 13300 10200 10 - 146 ug/Kg 4,6-Dinitro-2-methylphenol 13300 9260 ug/Kg 69 24 - 134 2-Nitrophenol 6670 5110 ug/Kg 77 46 - 106 13300 66 Pentachlorophenol 8820 ug/Kg 17 - 122Phenol 6670 4820 ug/Kg 72 41 - 102 6670 5160 77 48 - 108 2,4,5-Trichlorophenol ug/Kg 77 2,4,6-Trichlorophenol 6670 5120 ug/Kg 50 - 106 6670 76 Acetophenone 5040 30 - 150ug/Kg Atrazine 6670 4780 72 30 - 150 ug/Kg 74 Benzaldehyde 6670 4950 ug/Kg 30 - 150 1,1'-Biphenyl 6670 4440 ug/Kg 67 30 - 150 6670 96 Caprolactam 6430 ug/Kg 30 - 150 Bis(2-chloroethoxy)methane 6670 5140 ug/Kg 77 44 - 101 Bis(2-chloroethyl)ether 6670 4560 ug/Kg 68 38 - 99

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QC Sample Results

Client: KU Resources Inc

Project/Site: Center Street Parcel, McKeesport, PA TCV

TestAmerica Job ID: 180-38441-1

Method: 8270D - Semivolatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: LCS 180-123937/2-A

Matrix: Solid

Analysis Batch: 124983

Client Sample ID: Lab Control Sample Prep Type: Total/NA

Prep Batch: 123937

LCS LCS

Surrogate	%Recovery	Qualifier	Limits
Nitrobenzene-d5 (Surr)	84		25 - 104
Phenol-d5 (Surr)	74		25 - 105
2-Fluorobiphenyl	72		35 - 105
2,4,6-Tribromophenol (Surr)	67		35 - 124
2-Fluorophenol (Surr)	71		39 - 103
Terphenyl-d14 (Surr)	72		25 - 127

Client Sample ID: TT-02B Prep Type: Total/NA

Prep Batch: 123937

10

Lab Sample ID: 180-38441-4 MS

Matrix: Solid

Analysis Batch: 124983

Analysis Batch: 124983	Sample	Sample	Spike	MS	MS				%Rec.
Analyte	•	Qualifier	Added		Qualifier	Unit	D	%Rec	Limits
Acenaphthene	32		7610	5440		ug/Kg	- -	71	47 - 104
Acenaphthylene	230		7610	5660		ug/Kg	₩	71	49 - 114
Anthracene	220		7610	5860		ug/Kg	₩	74	45 ₋ 112
Benzo[a]anthracene	800		7610	6640		ug/Kg		77	47 _ 110
Benzo[a]pyrene	800		7610	6240		ug/Kg	₽	71	47 ₋ 112
Benzo[b]fluoranthene	1100		7610	5900		ug/Kg	₽	63	41 - 107
Benzo[g,h,i]perylene	780		7610	8010		ug/Kg	.	95	38 ₋ 126
Benzo[k]fluoranthene	390		7610	5190		ug/Kg	₽	63	44 ₋ 115
Bis(2-ethylhexyl) phthalate	ND		7610	7180		ug/Kg	₽	94	40 - 122
2,2'-oxybis[1-chloropropane]	ND		7610	4940		ug/Kg	₩.	65	36 - 101
4-Bromophenyl phenyl ether	ND		7610	5240		ug/Kg	₽	69	47 - 110
Butyl benzyl phthalate	ND		7610	6630		ug/Kg	₩	87	41 - 118
Carbazole	77	J	7610	5700		ug/Kg	\$	74	45 - 114
4-Chloroaniline	ND		7610	4680		ug/Kg	₩	61	25 - 108
2-Chloronaphthalene	ND		7610	4780		ug/Kg	₩	63	46 - 101
4-Chlorophenyl phenyl ether	ND		7610	6080		ug/Kg	₩.	80	47 - 109
Chrysene	860		7610	6920		ug/Kg	₩	80	46 - 111
Dibenz(a,h)anthracene	130	J	7610	7120		ug/Kg	₩	92	39 - 127
Dibenzofuran	110	J	7610	5720		ug/Kg	₩.	74	46 - 104
Di-n-butyl phthalate	ND		7610	5870		ug/Kg	₽	77	43 - 121
3,3'-Dichlorobenzidine	ND		7610	2350		ug/Kg	₩	31	19 - 122
Diethyl phthalate	ND		7610	5950		ug/Kg	₩.	78	47 ₋ 115
Dimethyl phthalate	ND		7610	5960		ug/Kg	₽	78	49 - 111
2,4-Dinitrotoluene	ND		7610	6130		ug/Kg	₽	81	45 - 124
2,6-Dinitrotoluene	ND		7610	5800		ug/Kg	₽	76	50 - 122
Di-n-octyl phthalate	ND		7610	6020		ug/Kg	₽	79	33 - 129
Fluoranthene	1300		7610	6620		ug/Kg	₽	70	40 - 120
Fluorene	45	J	7610	6060		ug/Kg	₽	79	46 - 109
Hexachlorobenzene	ND		7610	4840		ug/Kg	₽	64	47 - 108
Hexachlorobutadiene	ND		7610	6240		ug/Kg	₽	82	43 - 107
Hexachlorocyclopentadiene	ND		7610	5000		ug/Kg	\$	66	23 - 129
Hexachloroethane	ND		7610	5700		ug/Kg	₽	75	37 - 97
Indeno[1,2,3-cd]pyrene	710		7610	7190		ug/Kg	₽	85	41 - 125
Isophorone	ND		7610	6690		ug/Kg	₩.	88	47 - 110
2-Methylnaphthalene	160		7610	6210		ug/Kg	₽	79	45 - 100
Naphthalene	120	J	7610	6070		ug/Kg	≎	78	43 - 100

TestAmerica Pittsburgh

Client: KU Resources Inc Project/Site: Center Street Parcel, McKeesport, PA TCV

Method: 8270D - Semivolatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: 180-38441-4 MS

Matrix: Solid

Analysis Batch: 124983

Client Sample ID: TT-02B **Prep Type: Total/NA** Prep Batch: 123937

	Sample	Sample	Spike	MS	MS				%Rec.	
Analyte	Result	Qualifier	Added	Result	Qualifier	Unit	D	%Rec	Limits	
2-Nitroaniline	ND		7610	6840	-	ug/Kg	₩	90	45 - 117	
3-Nitroaniline	ND		7610	4820		ug/Kg	₩	63	34 - 122	
4-Nitroaniline	ND		7610	4960		ug/Kg	₩	65	38 - 123	
4-Nitrophenol	ND		15200	11700		ug/Kg	₩	77	36 - 127	
Nitrobenzene	ND		7610	6740		ug/Kg	₩	89	43 - 104	
N-Nitrosodi-n-propylamine	ND		7610	5960		ug/Kg	₩	78	42 - 107	
N-Nitrosodiphenylamine	ND		7610	5060		ug/Kg	₩.	67	44 - 111	
Phenanthrene	650		7610	5920		ug/Kg	₩	69	43 - 108	
Pyrene	1100		7610	6440		ug/Kg	₩	70	41 - 115	
4-Chloro-3-methylphenol	ND		7610	6390		ug/Kg	₩.	84	47 - 109	
2-Chlorophenol	ND		7610	5220		ug/Kg	₩	69	40 - 101	
2-Methylphenol	ND		7610	4450		ug/Kg	₩	58	40 - 104	
Methylphenol, 3 & 4	ND		7610	4890		ug/Kg	₽	64	42 _ 105	
2,4-Dichlorophenol	ND		7610	6020		ug/Kg	₩	79	47 - 105	
2,4-Dimethylphenol	ND		7610	3230	F1	ug/Kg	₩	42	44 - 105	
2,4-Dinitrophenol	ND		15200	6280		ug/Kg	₩	41	10 - 146	
4,6-Dinitro-2-methylphenol	ND		15200	8570		ug/Kg	₩	56	24 - 134	
2-Nitrophenol	ND		7610	6120		ug/Kg	₩	80	46 - 106	
Pentachlorophenol	ND		15200	8060		ug/Kg	₩.	53	17 - 122	
Phenol	ND		7610	5320		ug/Kg	₩	70	41 - 102	
2,4,5-Trichlorophenol	ND		7610	6120		ug/Kg	₩	80	48 - 108	
2,4,6-Trichlorophenol	ND		7610	5920		ug/Kg	₩	78	50 - 106	
Acetophenone	ND		7610	5480		ug/Kg	₩	72	30 - 150	
Atrazine	ND		7610	5670		ug/Kg	₩	74	30 - 150	
Benzaldehyde	ND		7610	2440		ug/Kg	₩	32	30 - 150	
1,1'-Biphenyl	ND		7610	5050		ug/Kg	₩	66	30 - 150	
Caprolactam	ND		7610	4760		ug/Kg	₩	62	30 - 150	
Bis(2-chloroethoxy)methane	ND		7610	5890		ug/Kg	₩	77	44 - 101	
Bis(2-chloroethyl)ether	ND		7610	5100		ug/Kg	₩	67	38 - 99	

Surrogate	%Recovery	Qualifier	Limits
Nitrobenzene-d5 (Surr)	90		25 - 104
Phenol-d5 (Surr)	71		25 - 105
2-Fluorobiphenyl	73		35 - 105
2,4,6-Tribromophenol (Surr)	66		35 - 124
2-Fluorophenol (Surr)	63		39 - 103
Terphenyl-d14 (Surr)	68		25 - 127

Lab Sample ID: 180-38441-4 MSD

Matrix: Solid

Analysis Batch: 124983

Client Sample ID: TT-02B **Prep Type: Total/NA**

Prep Batch: 123937

Sample	Sample	Spike	MSD	MSD				%Rec.		RPD
•	•	Added	Result	Qualifier	Unit	D	%Rec	Limits	RPD	Limit
32	J	7560	5620		ug/Kg	\$	74	47 - 104	3	40
230		7560	6000		ug/Kg	₽	76	49 - 114	6	38
220		7560	5770		ug/Kg	₽	73	45 - 112	2	42
800		7560	6440		ug/Kg	₽	75	47 - 110	3	40
800		7560	6150		ug/Kg	₽	71	47 - 112	1	42
	Result 32 230 220 800	220 800	Result Qualifier Added 32 J 7560 230 7560 220 7560 800 7560	Result Qualifier Added Result 32 J 7560 5620 230 7560 6000 220 7560 5770 800 7560 6440	Result Qualifier Added Result Qualifier 32 J 7560 5620 230 7560 6000 220 7560 5770 800 7560 6440	Result Qualifier Added Result Qualifier Unit 32 J 7560 5620 ug/Kg 230 7560 6000 ug/Kg 220 7560 5770 ug/Kg 800 7560 6440 ug/Kg	Result Qualifier Added Result Qualifier Unit D 32 J 7560 5620 ug/Kg 32 230 7560 6000 ug/Kg 32 220 7560 5770 ug/Kg 32 800 7560 6440 ug/Kg 32	Result Qualifier Added Result Qualifier Unit D %Rec 32 J 7560 5620 ug/Kg \$\frac{1}{2}\$ 74 230 7560 6000 ug/Kg \$\frac{1}{2}\$ 76 220 7560 5770 ug/Kg \$\frac{1}{2}\$ 800 7560 6440 ug/Kg \$\frac{1}{2}\$	Result Qualifier Added Result Qualifier Unit D %Rec Limits 32 J 7560 5620 ug/Kg \$\frac{104}{200}\$ 47 - 104 230 7560 6000 ug/Kg \$\frac{104}{200}\$ 49 - 114 220 7560 5770 ug/Kg \$\frac{104}{200}\$ 45 - 112 800 7560 6440 ug/Kg \$\frac{104}{200}\$ 47 - 110	Result Qualifier Added Result Qualifier Unit D %Rec Limits RPD 32 J 7560 5620 ug/Kg * 74 47 - 104 3 230 7560 6000 ug/Kg * 76 49 - 114 6 220 7560 5770 ug/Kg * 73 45 - 112 2 800 7560 6440 ug/Kg * 75 47 - 110 3

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QC Sample Results

Client: KU Resources Inc

Project/Site: Center Street Parcel, McKeesport, PA TCV

TestAmerica Job ID: 180-38441-1

Method: 8270D - Semivolatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: 180-38441-4 MSD

Matrix: Solid

Analysis Batch: 124983

4,6-Dinitro-2-methylphenol

Client Sample ID: TT-02B Prep Type: Total/NA

Prep Batch: 123937

· · ·					Batch: 1	
Benzo[b]fluoranthene 1100 7560 5640 Benzo[g,h,i]perylene 780 7560 8010 Benzo[k]fluoranthene 390 7560 5230 Bis(2-ethylhexyl) phthalate ND 7560 6710 2,2'-oxybis[1-chloropropane] ND 7560 4990 4-Bromophenyl phenyl ether ND 7560 5040 Butyl benzyl phthalate ND 7560 6160 Carbazole 77 J 7560 5710 4-Chloroaniline ND 7560 4390 2-Chloronaphthalene ND 7560 4990 4-Chlorophenyl phenyl ether ND 7560 6290 Chrysene 860 7560 6480 Dibenz(a,h)anthracene 130 J 7560 6880 Dibenzofuran 110 J 7560 6090	MSD			%Rec.		RPD
Benzo[g,h,i]perylene 780 7560 8010 Benzo[k]fluoranthene 390 7560 5230 Bis(2-ethylhexyl) phthalate ND 7560 6710 2,2'-oxybis[1-chloropropane] ND 7560 4990 4-Bromophenyl phenyl ether ND 7560 5040 Butyl benzyl phthalate ND 7560 6160 Carbazole 77 J 7560 5710 4-Chloroaniline ND 7560 4390 2-Chloronaphthalene ND 7560 4990 4-Chlorophenyl phenyl ether ND 7560 6290 Chrysene 860 7560 6480 Dibenz(a,h)anthracene 130 J 7560 6880 Dibenzofuran 110 J 7560 6090	Qualifier Unit	D	%Rec	Limits	RPD	Limit
Benzo[k]fluoranthene 390 7560 5230 Bis(2-ethylhexyl) phthalate ND 7560 6710 2,2'-oxybis[1-chloropropane] ND 7560 4990 4-Bromophenyl phenyl ether ND 7560 5040 Butyl benzyl phthalate ND 7560 6160 Carbazole 77 J 7560 5710 4-Chloroaniline ND 7560 4390 2-Chloronaphthalene ND 7560 4990 4-Chlorophenyl phenyl ether ND 7560 6290 Chrysene 860 7560 6480 Dibenz(a,h)anthracene 130 J 7560 6800 Dibenzofuran 110 J 7560 6000			60	41 - 107	5	53
Bis(2-ethylhexyl) phthalate ND 7560 6710 2,2'-oxybis[1-chloropropane] ND 7560 4990 4-Bromophenyl phenyl ether ND 7560 5040 Butyl benzyl phthalate ND 7560 6160 Carbazole 77 J 7560 5710 4-Chloroaniline ND 7560 4390 2-Chloronaphthalene ND 7560 4990 4-Chlorophenyl phenyl ether ND 7560 6290 Chrysene 860 7560 6480 Dibenz(a,h)anthracene 130 J 7560 6800 Dibenzofuran 110 J 7560 6000	,		96	38 - 126	0	43
2,2'-oxybis[1-chloropropane] ND 7560 4990 4-Bromophenyl phenyl ether ND 7560 5040 Butyl benzyl phthalate ND 7560 6160 Carbazole 77 J 7560 5710 4-Chloroaniline ND 7560 4390 2-Chloronaphthalene ND 7560 4990 4-Chlorophenyl phenyl ether ND 7560 6290 Chrysene 860 7560 6480 Dibenz(a,h)anthracene 130 J 7560 6880 Dibenzofuran 110 J 7560 6090	ug/Kg		64	44 - 115	1	44
4-Bromophenyl phenyl ether ND 7560 5040 Butyl benzyl phthalate ND 7560 6160 Carbazole 77 J 7560 5710 4-Chloroaniline ND 7560 4390 2-Chloronaphthalene ND 7560 4990 4-Chlorophenyl phenyl ether ND 7560 6290 Chrysene 860 7560 6480 Dibenz(a,h)anthracene 130 J 7560 6880 Dibenzofuran 110 J 7560 6090	ug/Kg		89	40 - 122	7	41
Butyl benzyl phthalate ND 7560 6160 Carbazole 77 J 7560 5710 4-Chloroaniline ND 7560 4390 2-Chloronaphthalene ND 7560 4990 4-Chlorophenyl phenyl ether ND 7560 6290 Chrysene 860 7560 6480 Dibenz(a,h)anthracene 130 J 7560 6880 Dibenzofuran 110 J 7560 6090	ug/Kg) [‡]	66	36 - 101	1	41
Carbazole 77 J 7560 5710 4-Chloroaniline ND 7560 4390 2-Chloronaphthalene ND 7560 4990 4-Chlorophenyl phenyl ether ND 7560 6290 Chrysene 860 7560 6480 Dibenz(a,h)anthracene 130 J 7560 6880 Dibenzofuran 110 J 7560 6090	ug/Kg) [‡]	67	47 - 110	4	46
4-Chloroaniline ND 7560 4390 2-Chloronaphthalene ND 7560 4990 4-Chlorophenyl phenyl ether ND 7560 6290 Chrysene 860 7560 6480 Dibenz(a,h)anthracene 130 J 7560 6880 Dibenzofuran 110 J 7560 6090	ug/Kg) [‡]	81	41 - 118	7	41
2-Chloronaphthalene ND 7560 4990 4-Chlorophenyl phenyl ether ND 7560 6290 Chrysene 860 7560 6480 Dibenz(a,h)anthracene 130 J 7560 6880 Dibenzofuran 110 J 7560 6090	ug/Kg) [‡]	74	45 - 114	0	36
4-Chlorophenyl phenyl ether ND 7560 6290 Chrysene 860 7560 6480 Dibenz(a,h)anthracene 130 J 7560 6880 Dibenzofuran 110 J 7560 6090	ug/Kg) [‡]	58	25 - 108	6	36
Chrysene 860 7560 6480 Dibenz(a,h)anthracene 130 J 7560 6880 Dibenzofuran 110 J 7560 6090	ug/Kg) [‡]	66	46 - 101	4	40
Dibenz(a,h)anthracene 130 J 7560 6880 Dibenzofuran 110 J 7560 6090	ug/Kg) [‡]	83	47 - 109	3	39
Dibenzofuran 110 J 7560 6090	ug/Kg	; ⇔	74	46 - 111	7	39
	ug/Kg	; ⇔	89	39 - 127	3	45
Di-n-butyl phthalate ND 7560 5670	ug/Kg	*	79	46 - 104	6	38
· ·	ug/Kg	\$	75	43 - 121	4	38
3,3'-Dichlorobenzidine ND 7560 2470	ug/Kg	;	33	19 - 122	5	40
Diethyl phthalate ND 7560 6240	ug/Kg)	83	47 _ 115	5	38
Dimethyl phthalate ND 7560 6200	ug/Kg	,	82	49 - 111	4	37
2,4-Dinitrotoluene ND 7560 6420	ug/Kg	,	85	45 - 124	5	41
2,6-Dinitrotoluene ND 7560 6290	ug/Kg)	83	50 - 122	8	40
Di-n-octyl phthalate ND 7560 5570	ug/Kg	,	74	33 - 129	8	41
Fluoranthene 1300 7560 6350			67	40 - 120	4	36
Fluorene 45 J 7560 6460	ug/Kg)	85	46 - 109	6	40
Hexachlorobenzene ND 7560 4850			64	47 - 108	0	43
Hexachlorobutadiene ND 7560 6110	ug/Kg	, ,	81	43 - 107	2	39
Hexachlorocyclopentadiene ND 7560 5030			67	23 - 129	1	49
Hexachloroethane ND 7560 5560			74	37 - 97	2	48
Indeno[1,2,3-cd]pyrene 710 7560 6960			83	41 - 125	3	47
Isophorone ND 7560 6270			83	47 - 110	6	37
2-Methylnaphthalene 160 7560 5790			74	45 - 100	7	40
Naphthalene 120 J 7560 5630	,		73	43 - 100	8	32
2-Nitroaniline ND 7560 6890		, 	91	45 - 117	1	42
3-Nitroaniline ND 7560 5260			70	34 - 122	9	39
4-Nitroaniline ND 7560 5070	,		67	38 - 123	2	40
4-Nitrophenol ND 15100 12100	.	, 	80	36 - 127	3	43
·				43 - 104	_	33
Nitrobenzene ND 7560 6320 N-Nitrosodi-n-propylamine ND 7560 6280			84	43 - 104 42 - 107	<i>7</i> 5	
	.	,	83	44 - 111	2	43
		,	68			
Phenanthrene 650 7560 5980		,	70	43 - 108	1	39
Pyrene 1100 7560 6300	ug/Kg		68	41 - 115	2	43
4-Chloro-3-methylphenol ND 7560 6520		, 				36
2-Chlorophenol ND 7560 5030		, ,	86	47 - 109	2	
2-Methylphenol ND 7560 4520	ug/Kg	, , *	67	40 - 101	4	42
Methylphenol, 3 & 4 ND 7560 4630	ug/Ko ug/Ko	, , *	67 60	40 ₋ 101 40 ₋ 104	4 2	42 41
2,4-Dichlorophenol ND 7560 6020	ug/Kg ug/Kg ug/Kg		67 60 61	40 ₋ 101 40 ₋ 104 42 ₋ 105	4 2 5	42 41 43
2,4-Dimethylphenol ND 7560 2930	ug/Kç ug/Kç ug/Kç ug/Kç		67 60 61 80	40 - 101 40 - 104 42 - 105 47 - 105	4 2 5 0	42 41 43 35
2,4-Dinitrophenol ND 15100 5340	ug/Kç ug/Kç ug/Kç ug/Kç F1 ug/Kç		67 60 61	40 ₋ 101 40 ₋ 104 42 ₋ 105	4 2 5	42 41 43

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7790

ug/Kg

52

24 - 134

15100

ND

11/17/2014

Project/Site: Center Street Parcel, McKeesport, PA TCV

Method: 8270D - Semivolatile Organic Compounds (GC/MS) (Continued)

Sample Sample

Lab Sample ID: 180-38441-4 MSD

Matrix: Solid

Analysis Batch: 124983

Client: KU Resources Inc

Client Sample ID: TT-02B Prep Type: Total/NA

Prep Batch: 123937

	Sample	Sample	Spike	MOD	MOD				%Rec.		KPD
Analyte	Result	Qualifier	Added	Result	Qualifier	Unit	D	%Rec	Limits	RPD	Limit
2-Nitrophenol	ND		7560	5990		ug/Kg	#	79	46 - 106	2	39
Pentachlorophenol	ND		15100	7920		ug/Kg	₩.	52	17 - 122	2	52
Phenol	ND		7560	5110		ug/Kg	₩	68	41 - 102	4	39
2,4,5-Trichlorophenol	ND		7560	5900		ug/Kg	₩	78	48 - 108	4	44
2,4,6-Trichlorophenol	ND		7560	6020		ug/Kg	₩	80	50 - 106	2	42
Acetophenone	ND		7560	5710		ug/Kg	₩	76	30 - 150	4	40
Atrazine	ND		7560	5620		ug/Kg	₩	74	30 - 150	1	40
Benzaldehyde	ND		7560	2240		ug/Kg	₽	30	30 - 150	9	40
1,1'-Biphenyl	ND		7560	5250		ug/Kg	₩	69	30 - 150	4	40
Caprolactam	ND		7560	4870		ug/Kg	₩	64	30 - 150	2	40
Bis(2-chloroethoxy)methane	ND		7560	6030		ug/Kg	₩	80	44 - 101	2	36

MSD MSD

5370

ug/Kg

Snike

7560

ND

	MOD	MOD	
Surrogate	%Recovery	Qualifier	Limits
Nitrobenzene-d5 (Surr)	85		25 - 104
Phenol-d5 (Surr)	73		25 - 105
2-Fluorobiphenyl	77		35 - 105
2,4,6-Tribromophenol (Surr)	65		35 - 124
2-Fluorophenol (Surr)	64		39 - 103
Terphenyl-d14 (Surr)	66		25 - 127

Method: 8082A - Polychlorinated Biphenyls (PCBs) by Gas Chromatography

Lab Sample ID: MB 180-124106/1-A

Matrix: Solid

Bis(2-chloroethyl)ether

Analysis Batch: 124338

Client Sample ID: Method Blank

38 - 99

Prep Type: Total/NA Prep Batch: 124106

	MB	MB							
Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
PCB-1016	ND		17	3.4	ug/Kg		11/06/14 03:45	11/08/14 01:36	1
PCB-1221	ND		17	4.2	ug/Kg		11/06/14 03:45	11/08/14 01:36	1
PCB-1232	ND		17	5.8	ug/Kg		11/06/14 03:45	11/08/14 01:36	1
PCB-1242	ND		17	4.2	ug/Kg		11/06/14 03:45	11/08/14 01:36	1
PCB-1248	ND		17	4.2	ug/Kg		11/06/14 03:45	11/08/14 01:36	1
PCB-1254	ND		17	4.0	ug/Kg		11/06/14 03:45	11/08/14 01:36	1
PCB-1260	ND		17	3.7	ug/Kg		11/06/14 03:45	11/08/14 01:36	1

MB MB

Surrogate	%Recovery	Qualifier	Limits	Prepared	Analyzed	Dil Fac
Tetrachloro-m-xylene (Surr)	85		45 - 135	11/06/14 03:45	11/08/14 01:36	1
DCB Decachlorobiphenyl (Surr)	93		45 - 125	11/06/14 03:45	11/08/14 01:36	1

Lab Sample ID: LCS 180-124106/2-A

Matrix: Solid

Analysis Batch: 124338

Client Sample ID: Lab Control Sample Prep Type: Total/NA

Prep Batch: 124106

	Spike	LCS	LCS				%Rec.	
Analyte	Added	Result	Qualifier	Unit	D	%Rec	Limits	
PCB-1016	 1330	1040		ug/Kg		78	55 - 135	
PCB-1260	1330	1170		ug/Kg		87	50 - 140	

TestAmerica Pittsburgh

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Method: 8082A - Polychlorinated Biphenyls (PCBs) by Gas Chromatography (Continued)

Lab Sample ID: LCS 180-124106/2-A

Matrix: Solid

Analysis Batch: 124338

Client Sample ID: Lab Control Sample Prep Type: Total/NA

Prep Batch: 124106

LCS LCS

Surrogate Limits %Recovery Qualifier Tetrachloro-m-xylene (Surr) 80 45 - 135 DCB Decachlorobiphenyl (Surr) 92 45 - 125

Lab Sample ID: 180-38441-4 MS Client Sample ID: TT-02B **Matrix: Solid**

Prep Type: Total/NA

Prep Batch: 124106

Prep Type: Total/NA

Analysis Batch: 124338 MS MS Sample Sample Spike %Rec.

Qualifier Added Result Qualifier D Analyte Result Unit %Rec Limits ₩ PCB-1016 ND 1510 1120 74 55 - 135 ug/Kg PCB-1260 Ü 260 1510 1240 ug/Kg 82 50 - 140

MS MS

Surrogate %Recovery Qualifier Limits 45 - 135 Tetrachloro-m-xylene (Surr) 78 DCB Decachlorobiphenyl (Surr) 86 45 - 125

Lab Sample ID: 180-38441-4 MSD Client Sample ID: TT-02B

Matrix: Solid

Analysis Batch: 124338

Prep Batch: 124106 MSD MSD RPD Sample Sample Spike %Rec. Analyte Result Qualifier Added Result Qualifier Unit D %Rec Limits **RPD** Limit 77 PCB-1016 ND 1520 1130 ug/Kg 74 55 - 135 0 20 PCB-1260 ₽ 260 1520 1250 ug/Kg 82 50 - 140 0 20

MSD MSD Surrogate %Recovery Qualifier Limits Tetrachloro-m-xylene (Surr) 77 45 - 135 DCB Decachlorobiphenyl (Surr) 86 45 - 125

11/17/2014

QC Association Summary

Client: KU Resources Inc

Project/Site: Center Street Parcel, McKeesport, PA TCV

TestAmerica Job ID: 180-38441-1

GC/MS Semi VOA

Prep Batch: 123937

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-38441-1	TT-01A	Total/NA	Solid	3541	
180-38441-2	TT-01B	Total/NA	Solid	3541	
180-38441-3	TT-02A	Total/NA	Solid	3541	
180-38441-4	TT-02B	Total/NA	Solid	3541	
180-38441-4 MS	TT-02B	Total/NA	Solid	3541	
180-38441-4 MSD	TT-02B	Total/NA	Solid	3541	
180-38441-5	TT-03A	Total/NA	Solid	3541	
180-38441-6	TT-03B	Total/NA	Solid	3541	
180-38441-7	TT-04A	Total/NA	Solid	3541	
180-38441-8	TT-04B	Total/NA	Solid	3541	
LCS 180-123937/2-A	Lab Control Sample	Total/NA	Solid	3541	
MB 180-123937/1-A	Method Blank	Total/NA	Solid	3541	

Analysis Batch: 124983

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-38441-1	TT-01A	Total/NA	Solid	8270D	123937
180-38441-3	TT-02A	Total/NA	Solid	8270D	123937
180-38441-4	TT-02B	Total/NA	Solid	8270D	123937
180-38441-4 MS	TT-02B	Total/NA	Solid	8270D	123937
180-38441-4 MSD	TT-02B	Total/NA	Solid	8270D	123937
180-38441-5	TT-03A	Total/NA	Solid	8270D	123937
180-38441-6	TT-03B	Total/NA	Solid	8270D	123937
180-38441-7	TT-04A	Total/NA	Solid	8270D	123937
180-38441-8	TT-04B	Total/NA	Solid	8270D	123937
LCS 180-123937/2-A	Lab Control Sample	Total/NA	Solid	8270D	123937
MB 180-123937/1-A	Method Blank	Total/NA	Solid	8270D	123937

Analysis Batch: 125132

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-38441-2	TT-01B	Total/NA	Solid	8270D	123937

GC Semi VOA

Prep Batch: 124106

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-38441-1	TT-01A	Total/NA	Solid	3541	_
180-38441-2	TT-01B	Total/NA	Solid	3541	
180-38441-3	TT-02A	Total/NA	Solid	3541	
180-38441-4	TT-02B	Total/NA	Solid	3541	
180-38441-4 MS	TT-02B	Total/NA	Solid	3541	
180-38441-4 MSD	TT-02B	Total/NA	Solid	3541	
180-38441-5	TT-03A	Total/NA	Solid	3541	
180-38441-6	TT-03B	Total/NA	Solid	3541	
180-38441-7	TT-04A	Total/NA	Solid	3541	
180-38441-8	TT-04B	Total/NA	Solid	3541	
LCS 180-124106/2-A	Lab Control Sample	Total/NA	Solid	3541	
MB 180-124106/1-A	Method Blank	Total/NA	Solid	3541	

TestAmerica Pittsburgh

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QC Association Summary

Client: KU Resources Inc

Project/Site: Center Street Parcel, McKeesport, PA TCV

TestAmerica Job ID: 180-38441-1

GC Semi VOA (Continued)

Analysis Batch: 124338

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-38441-1	TT-01A	Total/NA	Solid	8082A	124106
180-38441-2	TT-01B	Total/NA	Solid	8082A	124106
180-38441-3	TT-02A	Total/NA	Solid	8082A	124106
180-38441-4	TT-02B	Total/NA	Solid	8082A	124106
180-38441-4 MS	TT-02B	Total/NA	Solid	8082A	124106
180-38441-4 MSD	TT-02B	Total/NA	Solid	8082A	124106
180-38441-5	TT-03A	Total/NA	Solid	8082A	124106
180-38441-6	TT-03B	Total/NA	Solid	8082A	124106
180-38441-7	TT-04A	Total/NA	Solid	8082A	124106
180-38441-8	TT-04B	Total/NA	Solid	8082A	124106
LCS 180-124106/2-A	Lab Control Sample	Total/NA	Solid	8082A	124106
MB 180-124106/1-A	Method Blank	Total/NA	Solid	8082A	124106

General Chemistry

Analysis Batch: 124046

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-38441-1	TT-01A	Total/NA	Solid	2540G	-
180-38441-2	TT-01B	Total/NA	Solid	2540G	
180-38441-3	TT-02A	Total/NA	Solid	2540G	
180-38441-4	TT-02B	Total/NA	Solid	2540G	
180-38441-5	TT-03A	Total/NA	Solid	2540G	
180-38441-6	TT-03B	Total/NA	Solid	2540G	
180-38441-7	TT-04A	Total/NA	Solid	2540G	
180-38441-8	TT-04B	Total/NA	Solid	2540G	

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Proper 12. 963.7988 Fax: 412.963.2478 Regulatory Program: □ov □ovos 447 Chain of Custory ### College Contact College Contact Co

Client: KU Resources Inc Job Number: 180-38441-1

Login Number: 38441 List Source: TestAmerica Pittsburgh

List Number: 1

Creator: Skowronek, Elyse N

Question	Answer	Comment
Radioactivity wasn't checked or is = background as measured by a survey meter.</td <td>True</td> <td></td>	True	
The cooler's custody seal, if present, is intact.	True	
Sample custody seals, if present, are intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time.	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	True	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	